The Investigation of Innovation and Performance of Chinese Manufacturing Firms: The Role of Foreign Direct Investment, Formal Institutions and Research and Development Strategies

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Abstract

By employing an institution-based view, this thesis proposes that the innovation of indigenous firms is directly influenced by FDI and formal institutions and the latter also moderate the effects of the former. I use the *World Bank Enterprise Survey 2003 (WBES2003)*. The following findings are obtained: 1) FDI generates negative spillover effects on patents; 2) formal institutions positively affect innovation of firms; 3) formal institutions positively moderate the negative FDI innovation effects.

This thesis also looks at the role of formal institutions at regional level. It proposes that regional formal institutions and FDI affect the innovation of Chinese firms and also affect regional innovation. I use the *WBES2012*, *China Statistical Yearbook* and the *NERI Index of Marketization of China*. The following findings are obtained: 1) FDI generates no spillover effects on innovation; 2) regional formal institutions promote innovation of Chinese firms, while the study fails to discover such an impact from legal institutions; 3) regional formal institutions promote regional innovation.

In addition, this thesis also looks at the role of national innovation system (NIS) and a firm's R&D strategy in firm performance. It proposes that the performance of indigenous firms is directly affected by R&D strategy, NIS and FDI. Moreover, R&D strategy and NIS can also moderate FDI spillover effects. I use the *WBES2003*. The findings suggest the following: 1) firm performance is positively linked to the level of originality in a firm's R&D strategy; 2) NIS promotes firm performance; 3) FDI generates positive spillover effects on total sales; 4) FDI spillover effects are positively moderated by a firm's R&D strategy and NIS.

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This thesis is dedicated to my parents, Xuelian Qu and Yonghong Wang, for their support throughout my long journey to a PhD degree and for their endless love. Whenever I had difficulties and encountered hardships in my life and my study, they were always there being ready to help me, believe in me and encourage me. It would have been impossible for me to go through the tough period without their love, trust and support.

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Author’s Declaration

I hereby declare that this thesis ‘The Investigation of Innovation and Performance of Chinese Manufacturing Firms: The Role of Foreign Direct Investment, Formal Institutions and Research and Development Strategies’ is my original work and it has not been submitted, either in part or whole, for a degree at this or any other University. Wherever other sources of information are used every effort has been made to indicate this clearly, with due reference to the literature and acknowledgement of the contributions of others.

Chapter 1: Introduction

1.1 Research Background

Foreign direct investment (FDI) is seen as a carrier of practical knowledge, managerial skills and technologies that are used by multinational enterprises (MNEs) to overcome the liability of foreignness in host countries (Dunning and Lundan, 2008). FDI is an important channel of technological spillovers, especially for emerging countries. Supported by its cheap labour force, huge and growing indigenous markets, a large number of technical human resources and improved infrastructure, China has become one of the most attractive destinations for MNEs and one of the largest hosts of FDI in the world (Buckley et al., 2002). China has maintained its leading position as a top FDI recipient since 2002 (Global Business Policy Council, 2003). Now, it has become a magnet for foreign research and development (R&D) operations and foreign production. As many as 1,800 foreign-invested R&D centers were in operation in China by the end of 2012 (China Daily, 2013). The amount of FDI inflows was 111.7 billion US dollars in 2012 and this figure is expected to increase in the future (China Briefing, 2013). Chinese governments offer favorable policies in the hope of increasing the indigenous technology base through acquiring foreign technologies from FDI. However, Chinese governments have realized that relying on foreign technologies is not the only solution to achieving innovation and performance, and China has to go beyond that.

At the same time as recognizing the importance of relying on foreign technologies to develop the indigenous technology base and improve firms' innovation and performance, Chinese governments have consistently realized that promoting indigenous innovation and R&D with formal

institutional support and a national innovation system (NIS) is equally important. Formal institutions are formal rules that human beings have devised such as laws, regulations, property rights, contracts and constitutions, that structure economic, political and social interactions (North, 1990). This thesis only focuses on formal institutions. Formal institutions vary across regions, especially within a large emerging economy like China and formal institution in China have gone through tremendous changes since its opening up and reform (Liu et al., 2014). While, informal institutions are similar across regions in China and the changes in informal institutions are not as significant as they do in formal institutions (Hu, 2007; Lu et al., 2008). Chinese governments have been striving to build up formal institutions and NIS to facilitate indigenous R&D and innovation. As China aims to become an innovative country by 2020 and a world leader in innovation by 2050 (as stated in its Science and Technology Development Plan 2006-2020) (Boeing, 2010), the innovation and performance of Chinese firms, especially Chinese manufacturing firms (which attract most of the FDI and account for most of the innovation outcomes) are critical. Given the aspiration of promoting indigenous innovation of firms and becoming an innovative country, the promotion of formal institutions and NIS has appeared on the policy agenda of China. Affected by inward FDI and institutional development in China, Chinese firms adopt different R&D strategies. There are a large number of imitators in China which rely on foreign firms and imitate foreign products (Zhou, 2006). Meanwhile, many Chinese firms are enhancing their R&D capability and developing from imitators to innovators (Luo et al., 2011).

Understanding the determinants of innovation and performance of firms is important as they are the engine of economic growth (Grossman and Helpman, 1991). There are many existing studies on the determinants of innovation and performance (Cheung and Lin, 2004; Fu, 2008; Hu and

Jefferson, 2009; Ito et al., 2012; Sun and Du, 2010), but none consider formal institutions, NIS or R&D strategies. As one of the largest emerging economies, China provides a strong context in this regard as it has experienced tremendous changes in formal institutions and NIS, but also been characterized by its disparities in institutional development across regions (Liu et al., 2014). Different regions tend to have different regional institutions. Large emerging economies are featured by large income inequality, regional disparities and regional institutional diversity (Liu et al., 2014). Moreover, different R&D strategies are widely adopted by Chinese manufacturing firms and have significant effects on their performance. All the above suggest that there is a necessity to look into the formal institutions, NIS and R&D strategies as the driving forces behind the innovation and performance of Chinese manufacturing firms and regional innovation in China, and also how they may affect FDI spillover effects on Chinese firms. In order to address the above research gap, this thesis aims to examine the following three main research questions:

● What is the role of formal institutions and FDI in the innovation of China's manufacturing firms, and what is the role of formal institutions in FDI spillover effects?

● What is the role of regional formal institutions and FDI in the innovation of China's manufacturing firms, and in regional innovation in China?

● What is the role of R&D strategy, national innovation system and FDI in the performance of China's manufacturing firms, and what is the role of R&D strategy and national innovation system in FDI spillover effects?

1.2 Potential Contributions

This thesis intends to promote the research agenda of international business through investigating several main determinants of innovation and firm performance, namely, FDI, formal institutions, regional formal institutions, R&D strategy (duplicate imitation, creative imitation and original innovation) and NIS. It also assesses the roles that formal institutions, R&D strategy and NIS play in FDI spillover effects, given the increasing importance of FDI in China. This thesis intends to make a number of contributions.

Following the institution-based view, formal institutions should be put in the forefront rather than treated as "background" when investigating innovation of firms (Lu et al., 2008). This is even more necessary when studying emerging countries like China as she has a strong institutional impact on firms (Dunning and Lundan, 2008). However, among the existing studies that investigate the determinants of innovation (Cheung and Lin, 2004; Fu, 2008; Hu and Jefferson, 2009; Ito et al., 2012; Sun and Du, 2010), none considers the role of formal institutions in the innovation of firms. This thesis intends to fill this research gap through investigating the impact of formal institutions on the innovation of Chinese manufacturing firms. It explores three aspects of formal institutions, namely, government assistance, property rights protection and R&D services. This thesis also intends to extend the literature of FDI spillover effects through investigating the role of formal institutions in FDI spillovers.

In addition, existing studies on formal institutions tend to focus on national institutions (Edquist, 2006; Lu et al., 2008), neglecting the diversities across regions within a single country. Different regions tend to have different

regional formal institutions (Asheim et al., 2011). This is especially true when it comes to a large emerging economy like China. Moreover, as the engine of economic development, the determinants of innovation still require further exploration. In addition to the investigation of the role of formal institutions in innovation, there is also a need to look at the role of regional institutions in the innovation of Chinese firms. Also, regions in China tend to have different levels of innovation, so there is also a need to look at the role of regional institutions in regional innovation. Intending to enrich the literature of regional institutions, this thesis addresses the research gap and investigates the role of regional formal institutions in the innovation of Chinese manufacturing firms and in the innovation of regions in China.

Further, R&D is important for attaining competitive advantages and improving performance (Kim and Nelson, 2000). There are three different R&D strategies: duplicate imitation, creative imitation and original innovation. The existing research tends to focus mostly on innovation and firm performance (Garcia and Calantone, 2002). However, imitation is also a valid strategy, especially for firms in emerging countries as it may help firms achieve competitive advantages with lower costs and fewer resources than an innovation strategy. Imitation should be regarded as a spectrum which varies in magnitude and researchers need to consider the level of imitativeness versus the level of creativeness when investigating imitation (Luo et al., 2011). In this regard, the existing empirical studies make little distinction between whether the imitation is duplicate or creative. This inspires me that an investigation into the different types of imitation activities is a must-do step for better understanding of R&D strategies and their impact on firm performance. I put the investigation into the context of China as imitation is prevalent; also a large number of Chinese firms are evolving from being duplicate imitators to creative imitators, or from being

the latter to original innovators. Based on this train of thought, the thesis intends to enrich the literature of R&D strategy and address the research gap through assessing the role of R&D strategy in the performance of Chinese manufacturing firms, both directly and indirectly through their impact on FDI spillover effects.

Additionally, on the one hand, China has established various governmental institutions to build NIS and facilitate R&D. It has also increased R&D expenditure, aiming to set up NIS that generates R&D outcomes of high quality (Boeing, 2010).. Such efforts have borne fruit as the performance of many Chinese manufacturing firms is improving. On the other hand, despite the efforts made to promote R&D and innovation, illegal imitations and violations of property rights in China are still prevalent, and many Chinese manufacturing firms' performance is under threat (Gassmann et al., 2012). The effectiveness of China's NIS is raising doubts. This begs the question: whether or not China's NIS is effective in promoting firm performance? This thesis intends to make a contribution to the examination of the net impact of China's NIS on firm performance. Intending to extend the literature of NIS, this thesis looks into the impact of NIS on the performance of Chinese manufacturing firms, both directly and indirectly through their impact on FDI spillover effects.

1.3 Structure of the Thesis

This section presents the structure of the thesis and main content of each chapter.

Chapter 1 – Introduction

This chapter introduces the research background to the thesis and its

contribution to research.

Chapter 2 – An Overview of FDI, Formal Institutions, NIS and Innovation in China

This chapter presents an overview of FDI, formal institutions, NIS and innovation in China. It informs the following three empirical chapters and enriches them with background knowledge.

Chapter 3 – The Role of Formal Institutions and FDI in Innovation

This chapter utilises an institution-based view to examine the role of formal institutions and FDI in innovation in China's manufacturing firms. It also examines the role of formal institutions in FDI spillover effects.

Chapter 4 – The Role of Regional Formal Institutions and FDI in Innovation

Based on the institution-based view and the literature of regional institutions, this chapter investigates the role of regional formal institutions and FDI in the innovation of Chinese firms and in the innovation of regions in China.

Chapter 5 – Linking R&D Strategy, NIS and FDI to Firm Performance

This chapter assesses the impact of a firm's R&D strategy (duplicate imitation, creative imitation or original innovation), NIS and FDI on firm performance within China's manufacturing context. It also examines the role of R&D strategy and NIS in FDI spillover effects.

Chapter 6 – Conclusions

This chapter summarizes the key findings and contributions, and limitations of the thesis, suggests implications for corporate managers and policy makers, and identifies possible areas for future research in this field.

Chapter 2: An Overview of FDI, Formal Institutions, NIS and Innovation in China

2.1 Introduction

Understanding the determinants of innovation and performance of firms is important as they are the engine of economic growth (Grossman and Helpman, 1991). FDI is viewed as one important determinant of innovation in many existing studies (Cheung and Lin, 2004; Fu, 2008; Hu and Jefferson, 2009; Ito et al., 2012; Sun and Du, 2010). The prior literature rarely considers the role of formal institutions, NIS and R&D strategy in the innovation and performance of firms. This thesis fills the research gap by investigating their role in the innovation and performance of Chinese manufacturing firms, and in FDI spillover effects. This chapter presents background information regarding China's inward FDI, formal institutions, NIS and innovation. It aims to provide background information and knowledge for the following three empirical chapters. Below, section 2.2 reviews the history of China's inward FDI and its industrial distribution. Section 2.3 introduces China's formal institutions and their regional development. Section 2.4 presents China's NIS. Section 2.5 reflects innovation in China.

2.2 Inward FDI to China

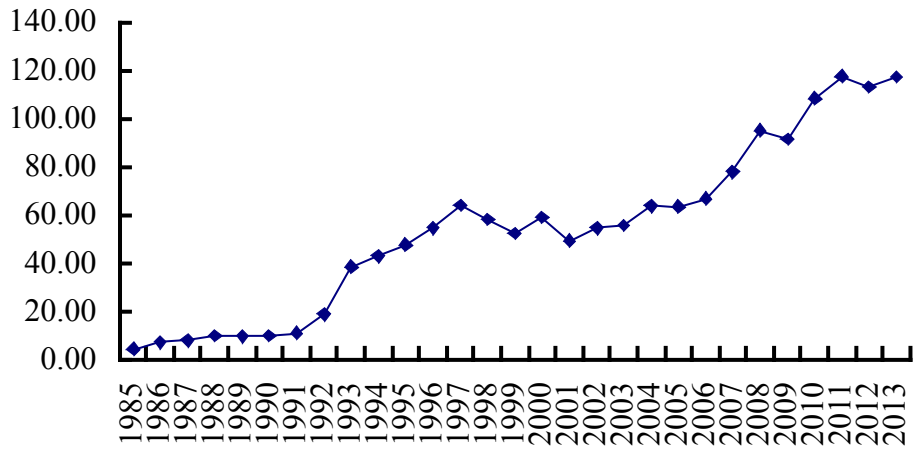
FDI has played a critical role in China's economic reform and development. It brings financial capital, managerial skills and knowledge, technologies and competition which are important for innovation and the performance of firms and regional innovation (Cheung and Lin, 2004). Since its reform and

opening up, China has made great endeavours to improve the investment climate and attract FDI, and the amount of inward FDI in China has experienced significant growth.

China issued the *Law On Chinese-Foreign Equity Joint Ventures* in 1979 and the *Regulations for the Implementation* in 1983, aiming to offer tax incentives and land credit and to open domestic market to foreign investors. Also, China set up four special economic zones in 1979 and 1980, and opened a further 14 coastal cities to foreign investors in 1984. Even so, such policies attracted little FDI and most of it was labour-intensive (Chen, 2011; Wei and Liu, 2001). Then, China opened the Yangtze River Delta and Pearl River Delta to foreign investors in 1985. The opening of Shanghai Pudong economic zone in 1990 represents a milestone of China's opening up and utilizing FDI. This is due to the fact that Shanghai is one of the most advanced regions in China and it has more developed formal institutions, business environment and investment climate than other regions in China. The opening of Shanghai economic zone opened windows and gave a sign and confidence to foreign investors to make investment in China. China issued the *Provisions for the Encouragement of Foreign Investment* in 1986, encouraging export-oriented FDI and technology-intensive FDI. In 1988, China issued the *Law on Chinese–Foreign Contractual Joint Ventures* to further Chinese-foreign economic cooperation. FDI inflow was accelerated (Chen, 2011; Wei and Liu, 2001). From 1992 to 1995, the contractual FDI increased by 48.6 percent and the utilized FDI increased by 150.7 percent (National Bureau of Statistics of China, 1996). This made China the largest destination of FDI among developing countries, and the second largest in the world. During this period, a large number of MNEs enlarged their investment in China, in the form of greenfield investment. High-tech and infrastructure sectors witnessed a significant growth in FDI (Chen, 2011). Then, China proposed to build up seven big economic zones in 1996 and

encouraged FDI to go to the middle and western regions of China. The 1997 Asian financial crisis negatively affected many countries, including some regions of origin of FDI to mainland China such as Hong Kong, Macao and Taiwan (HMT), and this resulted in the stagnation of growth of inward FDI in China in 1998 and recession in 1999. In order to stimulate FDI, China issued the *Catalogue of Industries for Guiding Foreign Investment* and offered tax reductions and exemption on foreign assets, aiming to extend the scope of industries open to foreign investors, encourage foreign R&D and increase the total amount of FDI inflows (Chen, 2011). China has become one of the top destinations of FDI since it became a formal member of the World Trade Organization (WTO) in 2001. From that moment on, China has to fulfill its commitments to WTO and reform its formal institutions, business environment and investment climate such as the reforms in legal system, industrial regulations and financial system. In 2002, the utilized FDI of China was 52.7 billion US dollars, with a growth rate of 12.6 percent over the previous year, which has made China the largest host of FDI from that year onward (Global Business Policy Council, 2003; National Bureau of Statistics of China, 2003). Then, Chinese governments offered policies and laws to regulate inward FDI regarding the scale of investment, technical advantages and modes of management, paying much attention to the "quality" of FDI, rather than merely "quantity" (Chen, 2011).

Figure 1 Utilized FDI Flows in China (US$ Billion)



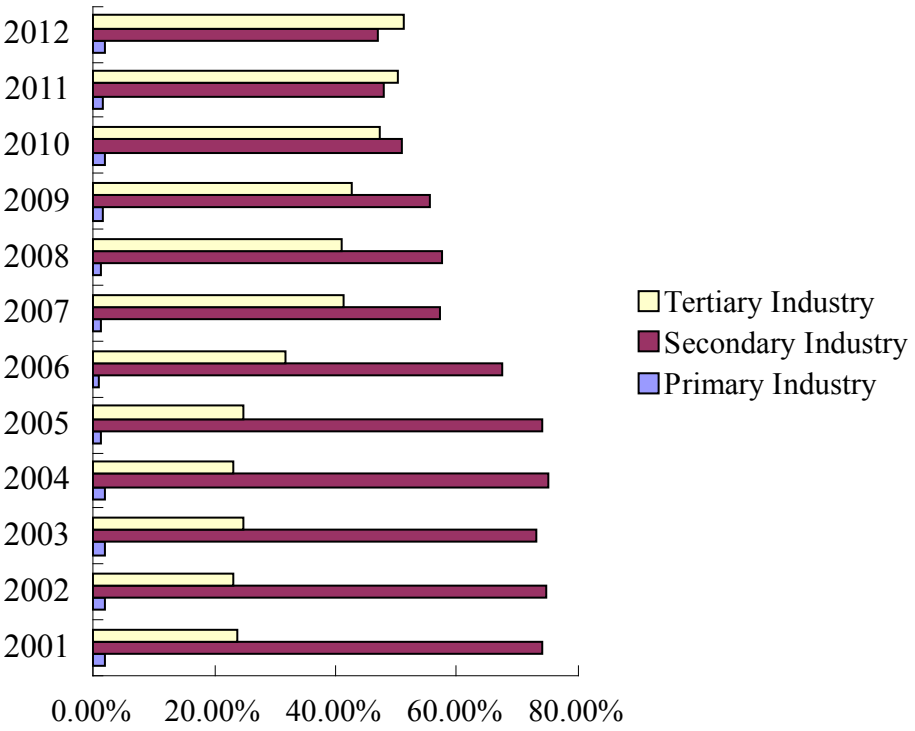
Source: National Bureau of Statistics of China, *China Statistical Yearbook 1986-2013*

Figure 1 reveals an overall growth of the utilized FDI in China over several years, but with different yearly growth rates. Also, it suggests that China experienced significant growth in utilized FDI between 1991 and 1997, and between 2001 and 2008. The utilized FDI is the amount of FDI that has been actually used by indigenous firms in host countries (China in this case) (National Bureau of Statistics of China, 2013).

Despite a large amount of FDI inflow every year, FDI is mostly directed to China's secondary industries, especially manufacturing which attracted a majority of inward FDI all the way through the decade starting from 2000, as shown by figures 2 and figure 3 below. The high concentration of inward FDI in Chinese manufacturing reminds me that there is quite a necessity to look into the impact of FDI on the innovation and performance of Chinese manufacturing firms. As FDI concentrated on China's manufacturing, many Chinese manufacturing firms pursued an imitation strategy and imitated foreign products, which affected their firm performance. Meanwhile, foreign technologies and R&D also affected Chinese firms' innovation

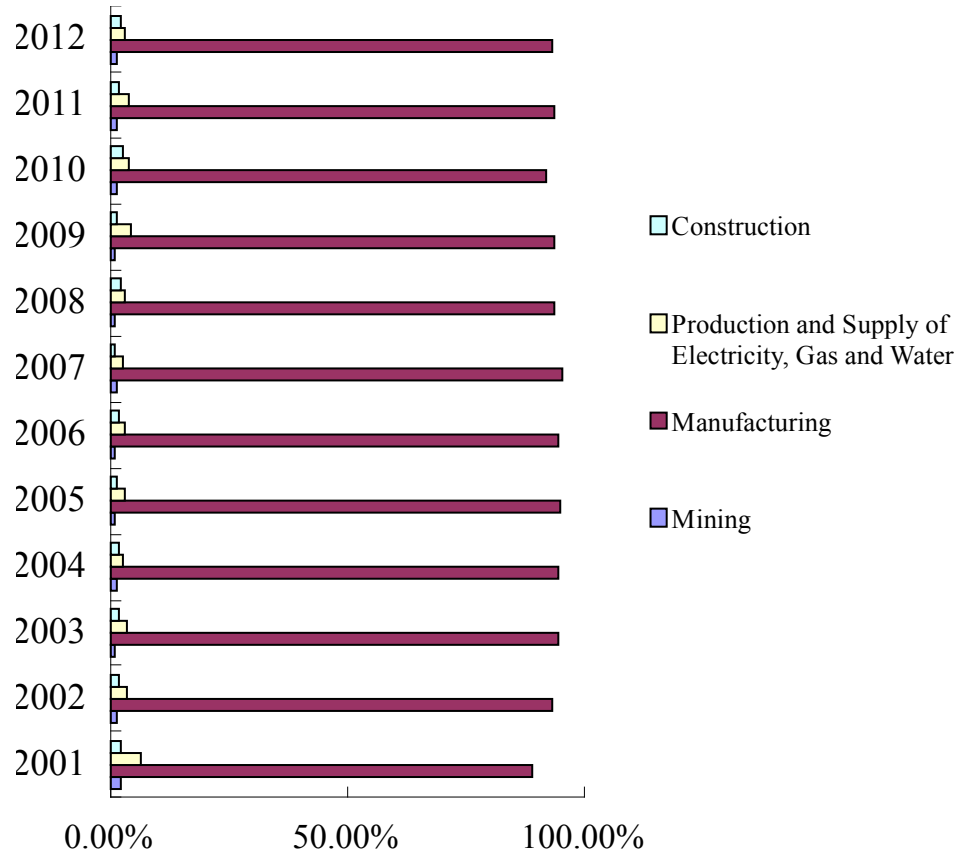
through generating spillover effects (Cheung and Lin, 2004; Liu, X., and Buck, T. 2007).

Figure 2 Distribution of Utilized FDI Flows among Chinese Industries



Source: National Bureau of Statistics of China, *China Statistical Yearbook 2002-2013*

Figure 3 Distribution of Utilized FDI Flows within Secondary Industry



Source: National Bureau of Statistics of China, *China Statistical Yearbook 2002-2013*

FDI has played a critical role in China's economic reform and development. However, the existing literature which studies the impact of FDI is restricted to areas such as export and productivity (Havranek and Irsova, 2011; Hu et al., 2005; Irsova and Havranek, 2013; Li et al., 2001; Liu et al., 2001). FDI also plays an important role in Chinese firms' innovation (Liu and Buck, 2007; Fu, 2008). Among the small group of studies which look at the role of FDI in the innovation of Chinese firms (Cheung and Lin, 2004; Fu, 2008; Hu and Jefferson, 2009; Ito et al., 2012; Sun and Du, 2010), none consider the role of formal institutions in innovation and FDI spillover effects. This is important as formal institutions may largely affect firms' innovation, regional innovation and the amount of FDI spillover effects absorbed by

firms (Meyer et al., 2009; Lu et al., 2008). Therefore, the formal institutions in China should be looked at.

2.3 China's Formal Institutions

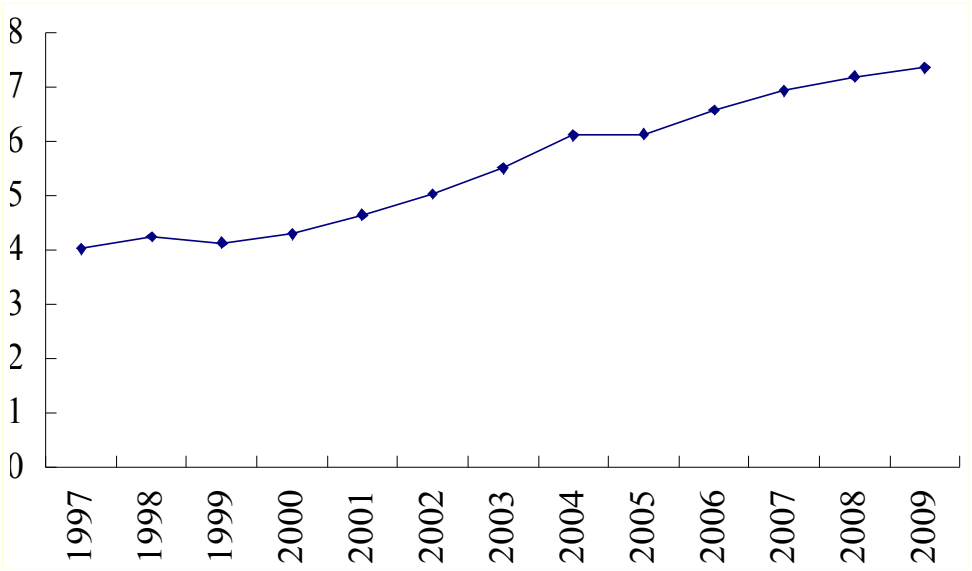
At the same time as receiving a large amount of inward FDI and acquiring foreign technologies, Chinese governments have been striving to build up formal institutions to facilitate indigenous innovation and improve firms' performance. As an important force behind firms' innovation, formal institutions in China should be looked at (Lu et al., 2008).

As there is no data which can directly reflect the development of Chinese formal institutions, I use the *Marketization Index Report 2011* compiled by the National Economic Research Institute (NERI) of China to approximately capture the institutional development in China. The *NERI Marketization Index Report 2011* reflects five main areas, including the relationship between governments and markets, the development of non-state-owned economy, the development of product markets, the development of factor markets and the development of intermediate organizations and legal institutions. Figure 4 is based on aggregate scores relating to performance in the above five areas of marketization. The aggregate scores are based on basic indicators of China's institutional development such as financial institutions, taxation institutions and legal institutions.

The NERI Marketization Index also has the feature of being comparable internationally and the relative progress of China in institutional development can be estimated. Zhu et al (2012) suggest that the relationship between governments and businesses such as taxation institutions, the development

of factor markets such as financial market, the development of non-state-owned businesses such as small- and medium-sized private firms, the development of intermediate organizations and the development of legal institutions are very important aspects of formal institutions which may affect the performance of firms significantly. The World Bank Group (2008) also reports that the development of product market such as the local protectionism and fairness in the market competition, the advancement of government efficiency, the advancement of financial support to businesses and the development of legal protection are important aspects of business environment and investment climate. As the NERI marketization index is based on the five areas of marketization and institutional development including the relationship between governments and markets, the development of non-state-owned economy, the development of product markets, the development of factor markets and the development of intermediate organizations and legal institutions which are identified as five important elements of formal institutional development and business environment by existing literature (e.g. Dunning and Lundan, 2008; North, 1990; Lu et al., 2008; Zhu et al., 2012), the findings from this thesis can be generalized to other countries such as emerging countries and Eastern Asian countries and the results from this thesis can become comparable internationally when the similar index on other countries are available, then the comparative studies can be carried out.

Figure 4 Overall Development of Formal Institutions in China



Source: Fan et al. (2011), *NERI Index of Marketization for China's Provinces: 2011 Report*[1]

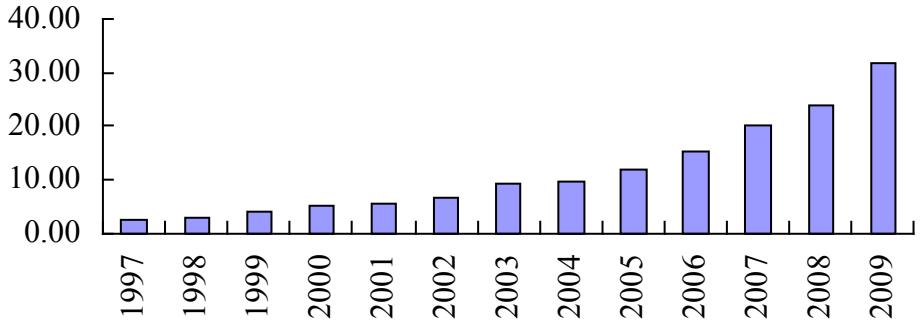
Figure 4 suggests that the overall formal institutional environment in China gradually improved from 1997 to 2009, while the rate of improvement increased after 2001, when China became a formal member of the WTO. This provides evidence that China has made significant improvements to its formal institutions since it jointed the WTO, in order to fulfil its commitments to the terms and conditions of the WTO and improve its investment climate for foreign investors. This is consistent with the observation from figure 1 that the amount of utilized FDI has experienced significant growth since 2001.

Legal institutions are the most important parts of formal institutions, and the development of legal institutions largely reflects the advancement of formal institutions (Dunning and Lundan, 2008). Also, legal institutions are important for firms' innovation and regional innovation as it provides protection for innovators' interests and returns and reduces the costs and

[1] Data after 2009 is unavailable

risks associated with R&D and innovation (Zhu et al., 2012). The *NERI Marketization Index Report 2011* provides the information on China's legal institutions. The index of legal institutions is comprised of three basic legal indicators including protection of producers' rights, protection of consumers' rights and protection of intellectual property rights. The range of values of these three basic indicators varies between 0 and 10. Figure 5 is based on the aggregate scores deriving from the three basic legal indicators. Figure 5 below reveals that China has experienced significant improvement in legal institutions since 1997 and the speed of improvement accelerated after 2002.

Figure 5 Overall Development of Legal Institutions in China



Source: Fan et al. (2011), *NERI Index of Marketization for China's Provinces: 2011 Report*

China's efforts towards institutional building have been witnessed in all the regions and provinces in China but with different levels of effectiveness and efficiency. With disparities in institutional development across regions, Chinese firms and regions tend to have different levels of innovation. Liu et al. (2014) suggest that large emerging economies feature high degrees of income inequality, regional disparity and regional institutional diversity. China presents a rich context to investigate regional formal institutions due

to its variation in institutional frameworks across regions. With 31 provinces, China is well-known for its heterogeneous regional institutions and regional disparity (Liu et al., 2014). For example, the World Bank Group (2008) indicates that it takes roughly 30 days to set up a new business in Zhejiang Province, whereas it takes about 50 days to do so in Qinghai Province. The *Economist* (2011) suggests that "China is now the world's second-biggest economy, but some of its provinces by themselves would rank fairly high in the global league. . . Shanghai's GDP per person is as high as Saudi Arabia's (at purchasing-power parity). . . .At the other extreme, the poorest province, Guizhou, has an income per head close to that of India." All of the above suggest that there is a need to look into the impact of China's institutions at regional level.

In the context of China, the uneven development of institutions across regions is explicitly reflected in areas such as government, financial, legal and educational institutions, all of which may affect local firms' innovation and regional innovation. In China, regional governments are granted the responsibility and authority for regional development and they control over half of the governmental budget (Naughton, 1995). With improved transparency and accountability in the usage of governmental budget, regional governments in China can directly affect the costs and incentives for innovation by firms and the level of innovation of a region. The resources provided by regional governments may largely affect firms' strategic choices and behaviours in innovation (Chan et al., 2010).

In addition, in China, access to finance is relatively easy to obtain in regions with strong financial institutions (Liu et al., 2014). Strong financial institutions help firms raise funds and undertake innovation. In contrast, within poor regional institutions, the level of financial marketization is low due to the inefficiency in the financial institutions which hinders firms'

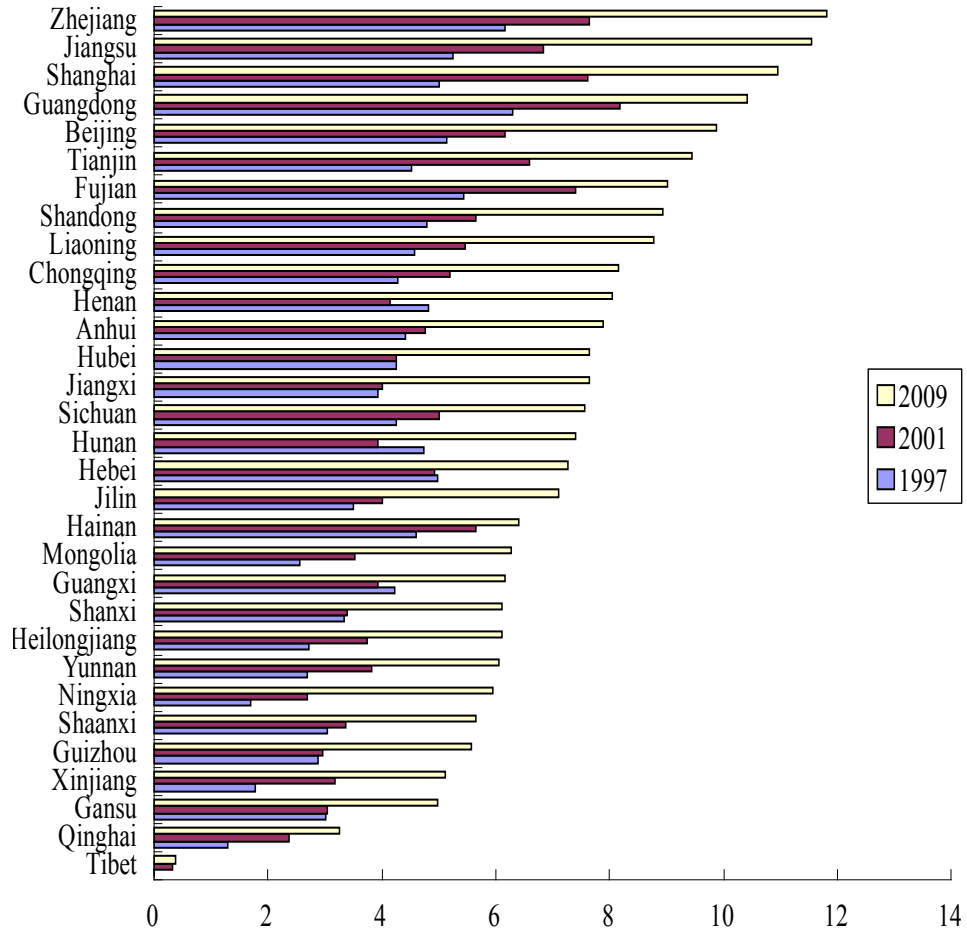
innovation and regional innovation. For example, it takes roughly a week to get credit from banks in Shanghai, while it takes about three weeks to do so in Qinghai Province (Liu et al., 2014). Such differences in the financial institutions across regions in China affect firms' speed of responding to market opportunities, thus incentives and opportunities of innovation.

Further, China has achieved significant progress in its legal system, but with uneven development across regions. In terms of law enforcement, the situation is also different across regions despite the fact that central government in China keeps emphasizing the significant role of law enforcement in innovation (Liu et al., 2014). Fan et al. (2011) suggest that outstanding law firms and capable lawyers are located mainly in the economically developed areas and coastal regions, whereas in the inland and western regions of China, qualified lawyers and high-quality legal services are costly to obtain. Such differences in the resources of the legal system across regions may produce different levels of impact on innovation of firms and regional innovation through generating different levels of protection, costs and incentives associated with R&D and innovation.

Finally, in a Chinese context, higher education has expanded remarkably over the past decade, but with uneven development across regions in terms of both quantity of educational institutions such as number of school, universities, private R&D labs and public R&D institutions and quality of education such as quality of teaching and efficiency in delivering knowledge and skills, which affects firms' innovation and regional innovation differently (Chi and Qian, 2009). Educational institutions are the foundation of human capital – one of the keys to innovation (Keune, 2001). China attempts to reduce the inequality of higher education across regions through building more schools and universities in under-developed regions and offering them preferential treatments such as giving them lower barrier

to enter universities. Despite lots of efforts being made, a large gap still remains. For example, R&D centres are normally located in coastal or eastern regions of China where there are high-quality educational institutions such as universities. Shanghai and Beijing, two metropolitan cities, are well-known for their educational institutions in both quantity and quality. Western provinces such as Qinghai, Tibet and Xinjiang are still far left behind in the development of educational institutions (Chi and Qian, 2009). The inequality in China's regional educational institutions is also reflected in the different levels of efficiency of regional governments in promoting and supporting the development of educational institutions across regions (The World Bank Group, 2008).

Figure 6 Progress of China's Regional Formal Institutions



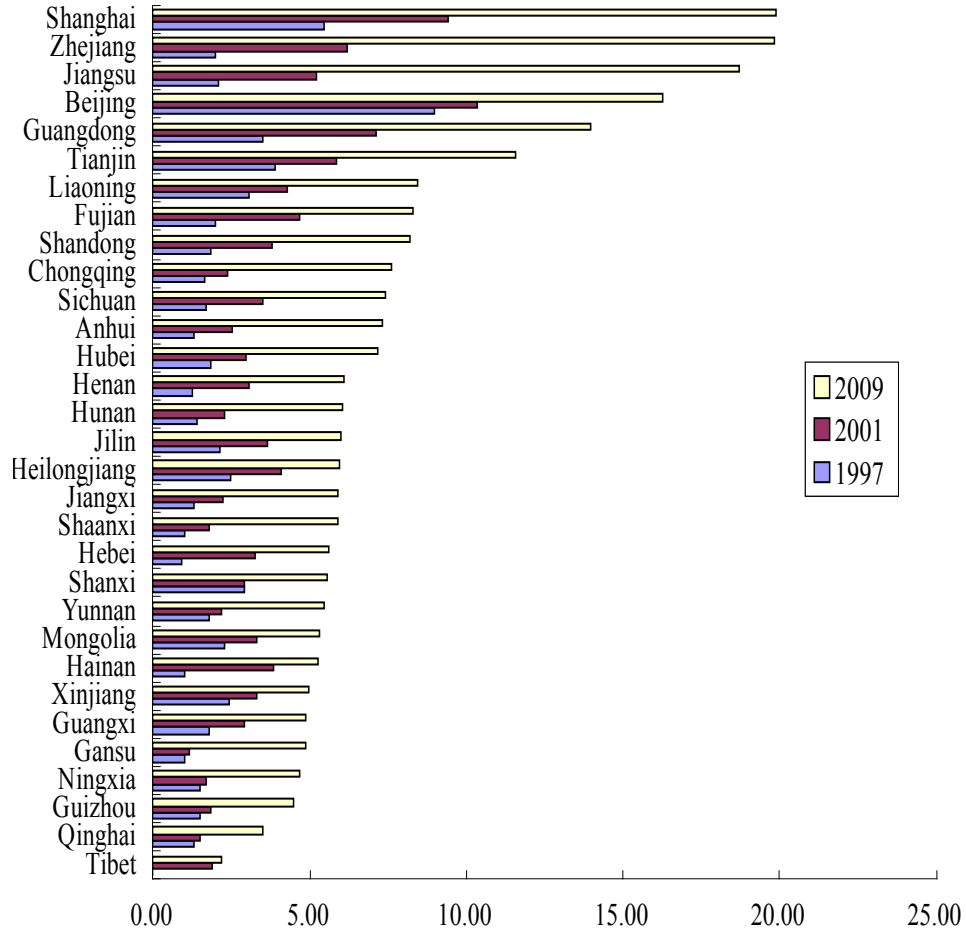
Source: Fan et al. (2011), *NERI Index of Marketization for China's Provinces:*

2011 Report[2]

Figure 6 illustrates that the formal institutions of all Chinese provinces have experienced significant development from 1997 to 2009 but with disparities, with Zhejiang, Jiangsu, Shanghai, Guangdong and Beijing being the top five in regional institutional development, and Tibet, Qinghai, Gansu, Xinjiang and Guizhou being the bottom five. The scores in figure 6 are produced based on a region's performance in the relationship between governments and markets, non-state-owned economy, product markets, factor markets and intermediate organizations and legal institutions. Figure 6 is based on aggregate scores relating to performance in the above five areas of marketization. The aggregate scores are based on basic indicators of China's institutional development such as financial institutions, taxation institutions and legal institutions.

[2] These three years were chosen because 1997 is the earliest year and 2009 is the latest year available, while, 2001 is a turning point when China jointed the WTO. The same reason applies to figure 7.

Figure 7 China's Legal Institutions across Regions



Source: Fan et al. (2011), *NERI Index of Marketization for China's Provinces: 2011 Report*

The *NERI Marketization Index Report 2011* provides the information on China's legal institutions across regions. The index of legal institutions is comprised of three basic legal indicators including protection of producers' rights, protection of consumers' rights and protection of intellectual property rights across regions. The range of values of these three basic indicators varies between 0 and 10. Figure 7 is based on the aggregate scores deriving from the three basic legal indicators. Figure 7 suggests that in terms of legal institutions, regions in China have experienced different levels of development, with Shanghai, Zhejiang, Jiangsu, Beijing and Guangdong being the top five, and with Tibet, Qinghai, Guizhou, Ningxia and Gansu

being the bottom five. This observation is consistent with what can be derived from figure 6, suggesting that legal institutions are a good reflection of formal institutions.

2.4 China's NIS

Given the growing importance of science and technology (S&T) in driving economic progress, the promotion of NIS has appeared on the policy agenda of many emerging economies (Zhong and Yang, 2007) and China has made tremendous efforts. Starting from 1999, China began to commercialize achievements in R&D (Tang and Hussler, 2011). In 2006, China implemented the Science and Technology Development Plan 2006-2020 (STDP 2006-2020), aiming to transform China into an innovative country by 2020 and a leader in innovation by 2050 (Boeing, 2010). China is now stimulating knowledge creation and diffusion by launching R&D projects, building R&D industrial parks, supporting private R&D organizations and promoting R&D networks (Yang, 2006). Appendix 1 illustrates that China has established various governmental institutions to facilitate R&D and promote NIS, among which the Ministry of Science and Technology (MOST) plays a critical role. These government institutions also interact with each other with the purpose of facilitating cooperation and building networks for innovation (Zhong and Yang, 2007).

The STDP 2006-2020 implemented by Chinese governments is an important reflection of China's objectives of building NIS. Table 1 below illustrates the eight targets of STDP, suggesting the various plans that Chinese governments have made to stress indigenous innovation and build NIS. These eight targets are associated with improvements in areas including: the agricultural science and technology sectors; pharmacy and medical equipment industries; manufacturing and information industries; energy

technology; defence technology; recycled economy; world-class scientists and research teams and research institutions and universities. Table 2 below shows that the Ministry of Science and Technology (MOST) is playing a key role in implementing STDP, facilitating R&D and building NIS through accomplishing its four main tasks. These four main tasks cover areas such as national strategies, regulations of Science and Technology (S&T), national S&T programmes, S&T systems, S&T resources, S&T cooperation, etc.

Table 1 Targets of STDP 2006-2020

Target 1	Agricultural science and technology sector as a whole becomes one of the most advanced in the world, so as to promote the comprehensive productive capabilities of agriculture and ensure food safety for the country, efficiently.
Target 2	There will be breakthroughs in energy exploration, energy-saving technology and clean energy technology, which may promote the structural optimization of energy, with energy consumption of major industrial products reaching or approaching world level.
Target 3	Major industries and key cities will set up a technological development mode of recycled economy, providing scientific and technological support to the building of a resource-efficient and environment-friendly society.
Target 4	Remarkable improvement will be achieved in the prevention and control of major diseases and epidemics, with serious diseases like AIDS and hepatitis well under control, while there will be breakthroughs in the development and manufacturing of new pharmacy and medical equipment and apparatus, with sufficient technological capabilities for industrialization.
Target 5	The development of defense technology will be able to meet the fundamental demands of self-reliant research and development of modern weapons and informationization of the Army, to provide assurance for the safeguarding of national security.
Target 6	A large number of world-class scientists and research teams will emerge in the country, who will be able to make a number of innovative achievements of great importance in the mainstream academic research, when China reaches world level in technologies in the fields of information, biology, materials and space.
Target 7	There will emerge a number of world-class research institutions and universities as well as internationally-competitive research and development centers owned by companies, which will form a relatively complete innovation system with China's own characteristics.
Target 8	Manufacturing and information industries are expected to master a number of core technologies that have a bearing on the country's national competitiveness, with its technological level of manufacturing and information sectors reaching world class.

Source: Yang (2006)

Table 2 Missions of the Ministry of Science and Technology (MOST)

Task 1	To set forth the national strategies, guidelines, policies and regulations of S&T; to determine major priority areas for Chinese S&T development; to boost the construction of National S&T Innovation System.
Task 2	To formulate national S&T programs and the relevant policies and measures; to take charge of the organization and management of these programs.
Task 3	To strengthen the reform of the S&T system; to optimize the allocation of S&T resources and human resources.
Task 4	To formulate guidelines and policies on China's international cooperation and exchanges in S&T; to take charge of bilateral and multilateral governmental S&T cooperation programs as well as those programs with relevant international organizations.

Source: MOST (2006)

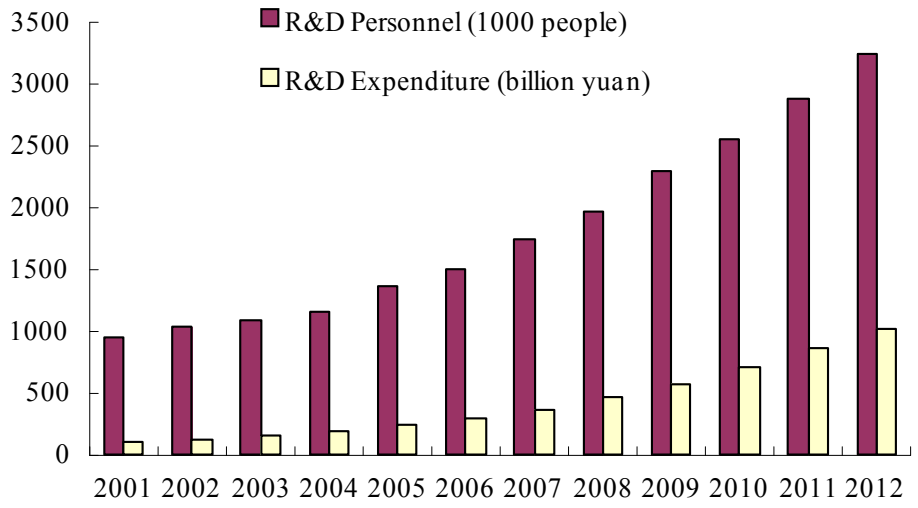
The building of NIS in China has had a significant impact on the innovation and performance of indigenous firms. On the one hand, China is making great efforts to stress indigenous innovation of firms and to support them to upgrade their R&D strategies. Chinese governments exert greater interventions than their counterparts in many advanced economies in affecting firms' R&D (Lu et al., 2008). In this circumstance, Chinese governments play an important role in allocating resources, providing supportive policies and building links between economic agents for firms' R&D (Lu et al., 2008). Moreover, Chinese governments are adopting multiple methods to attract new actors of R&D activities. They encourage foreign firms to engage in R&D through opening economic zones and reducing the amount of tax on foreign assets. China is also assisting firms with recruiting talent from around the globe and is trying to reduce the brain drain to abroad. These actions have helped indigenous firms with their innovation and performance. While, on the other hand, despite lots of effort being made, there is still a large gap between China's current NIS and the one that it aims to have. For example, the legal system is one important

aspect of NIS (Lundvall, 2007); in this regard, the protection of producers' rights, consumers' rights and intellectual property rights are still weak and the enforcement of laws is not very efficient (Athanasakou, 2007; Gassmann et al., 2012). The intellectual property theft and violations have increased rapidly in both volume and range of products affected. The amount of illegal imitation, pirated products and counterfeit goods increases at the same speed as the legal outputs. (Gassmann et al., 2012). Besides, despite Chinese governments encouraging of indigenous R&D and building NIS to support innovation, a large number of Chinese firms still rely heavily on foreign technologies, imitate foreign products and are reluctant to make the move to innovate (Xie and White, 2006; Zhou, 2006). The effectiveness of China's NIS raises doubts.

2.5 Innovation in China

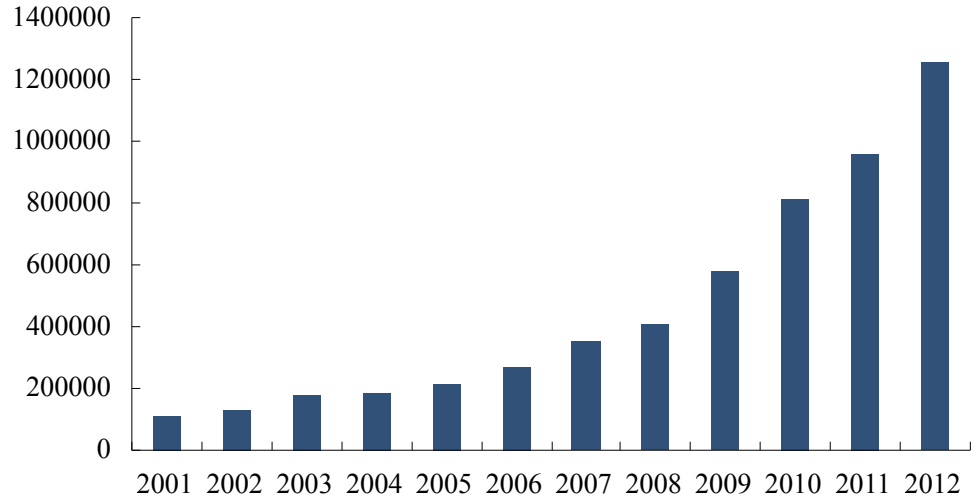
China has gone through a significant growth in both R&D inputs and outputs, which reflects the willingness of Chinese governments to promote indigenous innovation and the improvement in Chinese firms' innovation capability. It also reflects the positive changes in China's formal institutions, regional formal institutions and NIS.

Figure 8 R&D Inputs



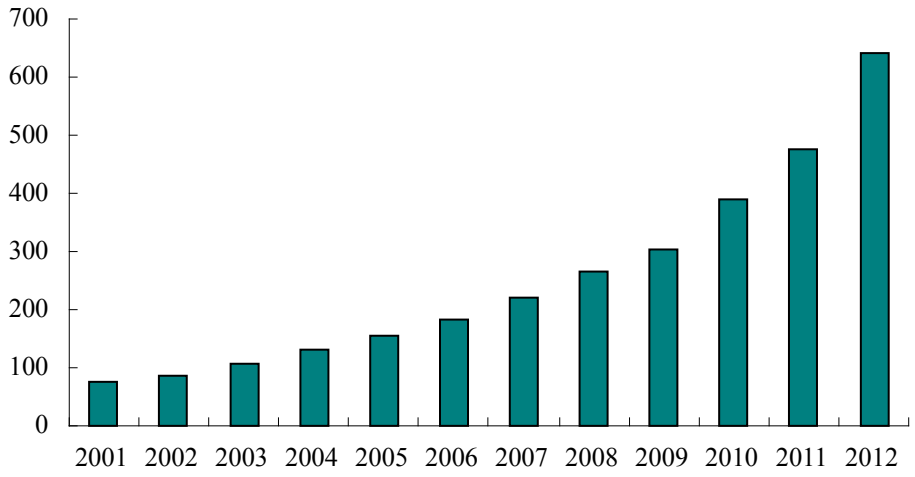
Source: National Bureau of Statistics of China, *China Statistical Yearbook 2002-2013*

Figure 9 Patents Granted



Source: National Bureau of Statistics of China, *China Statistical Yearbook 2002-2013*

Figure 10 Volume of Tractions in Technology Market (Billion Yuan)



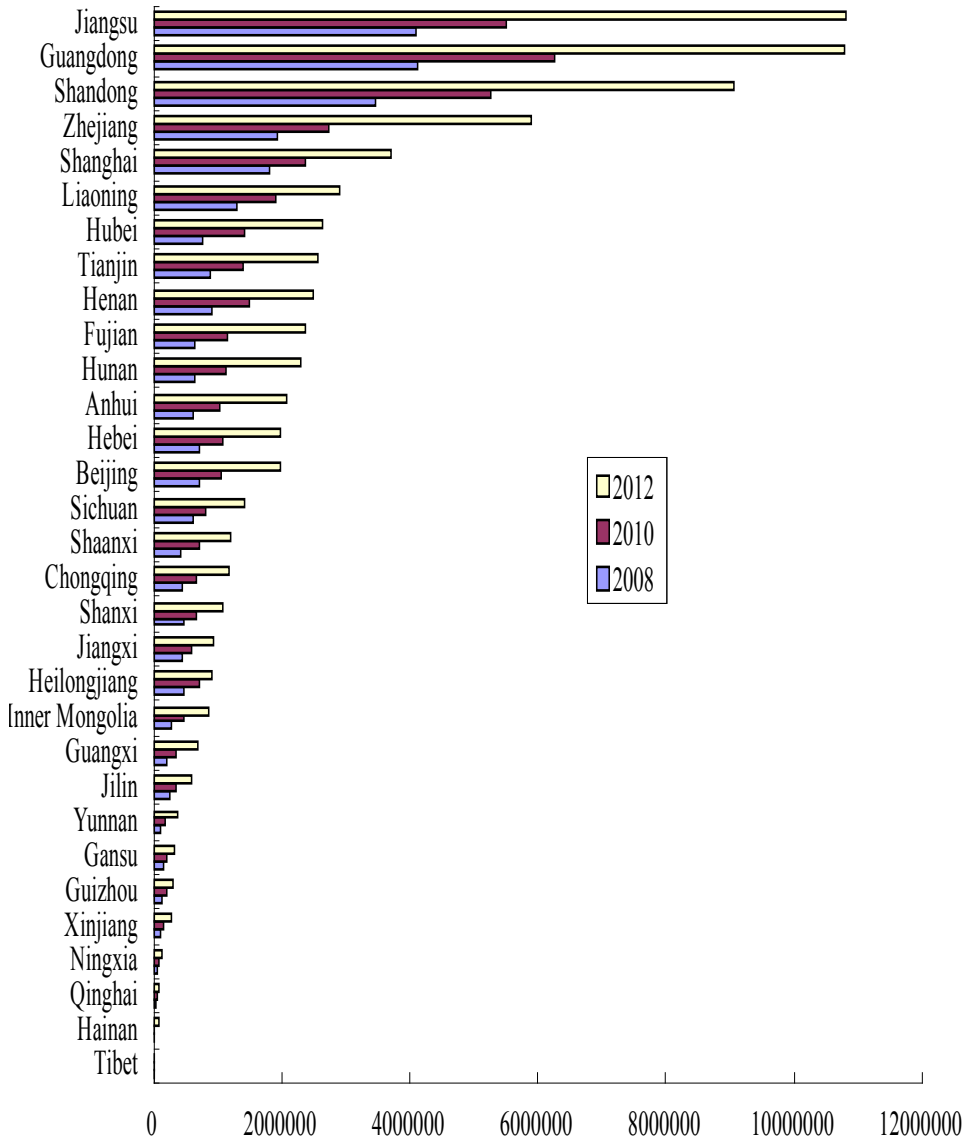
Source: National Bureau of Statistics of China, *China Statistical Yearbook 2002-2013*

Figures 8-10 reveal the R&D and innovation in China over recent years. The R&D inputs: R&D personnel and R&D expenditure have increased steadily every year. As the R&D outputs increase, the number of patents granted and tractions in the technology market have increased steadily over the years as well. The growth rate of R&D and innovation in China increased after 2006. The above observation from another side reveals the overall growth in innovation capability of Chinese firms. It is true that a large number of Chinese firms are currently using imitation strategy over innovation strategy and rely heavily on foreign technologies (Xie and White, 2006; Zhou, 2006), while, there are also many Chinese firms that have successfully upgraded their strategy in R&D and transformed to innovators. Tianyu, one of China's largest mobile phone producers, started as a duplicate imitator of Motorola and Nokia, and then evolved to be a creative imitator via improving and developing the original designs from external sources (Lee and Zhou, 2012). Many successful Chinese innovators today such as Huawei, ZTE, Haier, Lenovo and TCL were once imitators (duplicate or creative imitators). Their current success and competitiveness in R&D come from their capabilities to

develop firm-specific competitive advantages and adopt technologies from external sources. Their previous imitation activities have formed the knowledge base for them to achieve further R&D and creations (Xie and White, 2006). The Time Group, during its start-up stage, relied on imitating foreign products with expiring patents to develop products of its own. As The Time Group develops, the in-house R&D becomes the firm's foundation for developing new products and the firm eventually becomes an innovator (Brambilla et al, 2009).

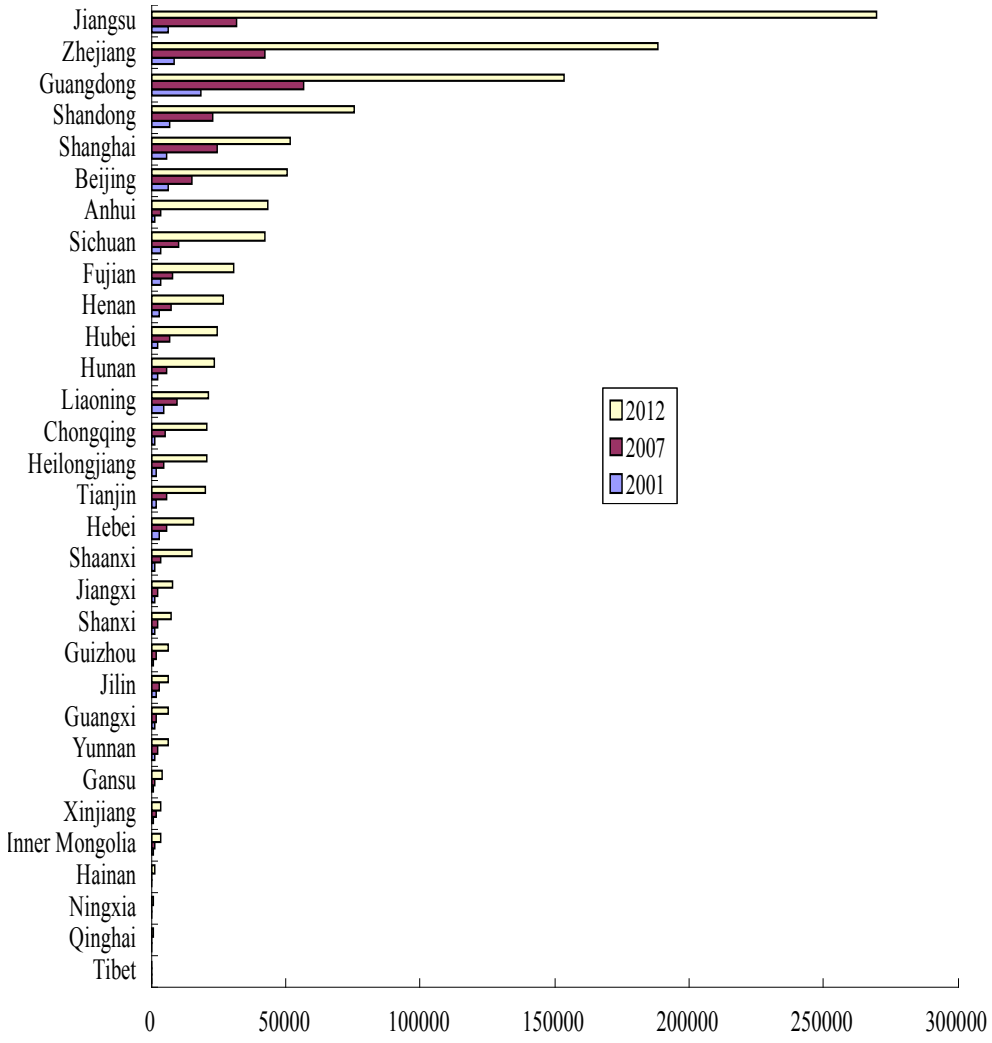
Furthermore, different regions tend to have different levels of innovativeness and this is especially true for a large emerging economy like China which has 31 provinces. For example, in China, the eastern and coastal regions tend to be more technologically advanced and have more R&D inputs and outputs. While, the overall R&D inputs and outputs tend to be much less intensive in the western and inland regions of China, which can be observed from the two figures below.

Figure 11 R&D Expenditure among Provinces (10,000 Yuan)



Source: National Bureau of Statistics of China, *China Statistical Yearbook 2002-2013*

Figure 12 Patents Granted among Provinces



Source: National Bureau of Statistics of China, *China Statistical Yearbook 2002-2013*

Figures 11 and figure 12 above suggest that Jiangsu Province, Guangdong Province, Zhejiang Province, Shandong Province and Shanghai Municipality rank the top five in R&D expenditure and the number of patents granted. These five regions went far beyond others, representing the most R&D intensive and innovative regions in China. Overall, regions in China have experienced an uneven development in innovation, which deserves further investigation of the driving forces behind this situation.

Chapter 3: The Role of Formal Institutions and FDI in Innovation

3.1 Introduction

There is a consensus that innovation is the engine of economic growth (Grossman and Helpman, 1991). When China launched its open door policy in 1978[3], the priority was to increase the indigenous technology base through acquiring foreign technologies in order to accelerate the growth trajectory. Since then, the Chinese government has been striving to build up formal institutions to facilitate innovation and R&D. Over 35 years on, China's impressive growth rate is widely acknowledged, so is the role of FDI and its agents – multinational enterprises (MNEs) in this process (Wei and Wang, 2009). China has become a magnet for foreign manufacturing facilities and has attracted foreign R&D operations. It has maintained its leading position as a top FDI recipient since 2002 (Global Business Policy Council, 2003). As many as 1,200 foreign-invested R&D centres had been in operation in China by 2007 (Cao et al., 2009). MNEs' R&D activities cover a wide spectrum, ranging from production support, product adaptation, new product development and applied research to basic research. Meanwhile, formal institutions in China have also experienced plentiful changes. Thus begs the question: have China's integration into the world in production and R&D and its changed formal institutions accelerated innovation by Chinese indigenous firms?

[3] It is the economic policy initiated by Chinese leader Xiaoping Deng in 1978. It aimed to open up China to foreign investors and businesses. This policy led China to economic transformation.

FDI is often considered a carrier of managerial skills, advanced knowledge and technologies, and it can affect innovation of indigenous firms in several ways including the introduction and demonstration of new knowledge and skills, access to finance, the training and embedment of human resources and the enhancement of competition (Cheung and Lin, 2004; Chen and Mohnen, 2009; Lin and Lin, 2010). The first three channels have positive effects, but the role of competition is rather mixed. Because of the increased competition, indigenous firms may gear up their innovation commitments in order to stay in the market. Equally possible, their innovative efforts may be thwarted due to the increased costs and risks associated with competition. The net FDI spillover effects therefore need to be resolved by empirical testing. A number of studies have examined the impact of FDI spillovers on innovation in China (Cheung and Lin, 2004; Fu, 2008; Girma et al., 2008; Girma et al., 2009; Ito et al., 2012; Li et al., 2010; Liu and Buck, 2007; Liu and Zou, 2008; Wang and Kafouros, 2009). However, the findings are mixed. Among these studies, none consider the role of formal institutions in innovation in general, and in FDI spillovers in particular, despite the recognition of the strong influence of governments on the economy and the fundamental change of formal institutions in China since its opening up (Baark, 2007; Xu, 2011).

Formal institutions are defined by North (1990) as formal rules that human beings have devised, such as constitutions, laws, regulations, property rights and contracts, that structure political, economic and social interactions. This corresponds to the regulative pillar of the institutional profile suggested by Scott (1995). Formal institutions elicit rule-setting, monitoring and sanctioning activities performed by various actors in the public and private sectors such as governments, businesses and universities (Chang and Shih, 2004). Formal institutions change over time and they are different across regions, especially it is especially true when it comes to China which is one

of the largest emerging economies (Dunning and Lundan, 2008). The formal institutions in China have gone through lots of changes over the past three decades (Liu et al., 2014). However, informal institutions in China are quite similar across regions and there were not as many changes happened to informal institutions as they do to formal institutions (Hu, 2007; Lu et al., 2008). This thesis focuses on formal institutions also because of the failure of this thesis to disentangle the effect of informal institutions from that of formal institutions and I have acknowledged this point as one limitation in chapter 6. Formal institutions are critical for innovation. First of all, organizations undertaking innovation are deeply embedded in institutions (Edquist, 2006). Their creative activities of knowledge and know-how, the results of innovation, are constrained by institutions. In addition, innovation must fit to institutional requirements and be consistent with institutional codes of conduct. Institutional requirements encourage certain behaviour but restrict others (Lu et al., 2008). Further, institutions such as a property right protection system affect the efficiency and effectiveness of innovation creation and diffusion (Lu et al., 2008). Strong institutions assist innovation because they permit firms to appropriate income from innovation while weak institutions deter innovation because firms are not incentivized to allocate resources to economically innovative activities. Following the institution-based view, formal institutions should be put in the forefront rather than treated as "background" when investigating the innovation of firms (Lu et al., 2008). A systematic empirical investigation of the link between the innovation of Chinese indigenous firms and formal institutions in China is therefore required.

Formal institutions also moderate the impact of FDI on innovation. When there are positive FDI spillovers, strong institutions where formal rules are used in a transparent and predictable manner provide incentives for registering new patents, diffusing new knowledge and ideas, enforcing

property rights protection and reducing risks and uncertainties. In the condition of negative FDI spillovers, strong institutions can mitigate the negative effects through constraining opportunistic behaviour and building transactional trust between parties. In contrast, weak institutions may fail to take advantage of the positive impact or constrain the negative one associated with FDI as they fail to facilitate the diffusion and/or assimilation of knowledge by indigenous firms. To the best of my knowledge, no study has so far paid attention to the role of institutions in FDI spillover effects.

This chapter addresses two major research questions. First, to what extent do institutions constrain or facilitate indigenous firms' innovation in China? Second, what is the role of institutions in the process of FDI spillovers? After reviewing the literature on the role of FDI in innovation, the chapter utilises an institution-based view to the examination of the role of formal institutions in innovation and FDI spillovers. I propose that indigenous firms' innovations are directly influenced by FDI spillovers and formal institutions and the latter also moderate the effects of the former. Bearing in mind the mixed findings on the role of FDI in innovation in the existing literature, this chapter uses a range of measurements representing different aspects of innovation in order to find a comprehensive picture on the role of formal institutions and FDI in innovation. Below, section 3.2 reviews existing literature. This is followed by discussion of data and methodology in section 3.3. Section 3.4 provides empirical findings, with discussion and conclusion in sections 3.5 and 3.6 respectively.

3.2 Literature Review

3.2.1 FDI Spillovers and Innovation

In existing literature, the role of FDI in economic development has been recognized by many studies (Havranek and Irsova, 2011; Hu et al., 2005; Irsova and Havranek, 2013; Li et al., 2001; Liu et al., 2001). For example, latest literature regarding the productivity spllovers from FDI such as Havranek and Irsova (2011) and Irsova and Havranek (2013) suggest that FDI could affect the both the costs and opportunities of enhancing productivity of indigenous firms, and FDI can also affect the efficiency of productivity enhancement. While, besides the extensive literature on the productivity spillovers from FDI, an extensive literature on the knowledge spillovers from FDI has emerged in recent decades (Crespo and Fontoura, 2007; Görg and Greenaway, 2004; Meyer and Sinani, 2009; Smeets, 2008; Wooster and Diebel, 2010), although most studies are still somehow associated with the impact of FDI on productivity. FDI can affect innovation of indigenous firms through a number of channels including demonstration effects, labour mobility, access to finance, and competition effects (Cheung and Lin, 2004; Chen and Mohnen, 2009; Lin and Lin, 2010).

There is a high degree of persistence in the innovative behaviour of MNE. They contribute to the technological upgrading of host countries (Álvarez and Marín, 2010). Through FDI, MNEs transfer knowledge, the result of innovation, to host countries (Alvarez and Marin, 2013; Dellestrand and Kappen, 2011). It is possible for indigenous firms to learn some of the knowledge carried by foreign firms through learning-by-doing, learning-by-watching and reverse engineering, and to develop new products and processes (Cheung and Lin, 2004). The knowledge is firm-specific asset which forms the competitive advantage of firms. The transfer of knowledge

between firms and the amount of technology spillovers generated are affected by both the willingness of foreign firms to do R&D locally and the level of absorptive capacity of indigenous firms (Cohen and Levinthal, 1989, 1990; Zhou, 2006). In addition, skilled employees move from MNEs to local firms or they set up their own companies and bring with them the knowledge embedded in MNEs which may contribute to indigenous firms' innovative activities (Cheung and Lin, 2004). Further, MNEs inject much-needed funds into the local economy for innovation as innovation is costly and risky (Girma et al., 2008). Moreover, MNEs' affiliates will render the market they enter more competitive, forcing indigenous firms to engage in innovation in order to stay in competition (Girma et al., 2008). These arguments point to the positive impact of FDI.

Conversely, FDI can discourage indigenous firms from innovation. MNEs may "crowd out" indigenous firms in both resource and product markets (Girma et al., 2008). They compete with indigenous firms for capital, land and skilled labour, which forces up the production and operating costs of indigenous firms and reduces their profitability, and resources available for their own innovation or to take advantage of spillovers from FDI. Because of their strong reputation, MNEs may have an advantage over indigenous firms in securing bank loans. MNEs often provide more attractive offers to local talent, which pushes up wages. Indigenous firms may also lose out in the provision of final goods and services because of MNEs' strength in brand names and quality of the products (Dunning and Lundan, 2008). As a result, the competitive pressure associated with FDI presence may be harmful to local innovation.

Given the above debate, the net impact of FDI spillovers on innovation is not clear-cut. It can be positive, negative and/or statistically insignificant and therefore needs to be resolved by empirical testing. It is unsurprising,

therefore, to observe that findings are rather mixed, even for studies within a single country. Among a number of studies on the role of FDI in innovation in China, positive spillovers are found in Cheung and Lin, 2004; Fu, 2008; Hu and Jefferson, 2009; Ito et al., 2012; Sun and Du, 2010, negative spillovers in Girma et al., 2008; Zhang and Rogers, 2009, while, statistically insignificant spillovers are reported in Sun, 2000 and Sun and Du, 2010.

3.2.2 Formal Institutions and Innovation

It has been claimed that an institution-based view "has been relatively neglected in the study of knowledge management and innovation in the Asia Pacific region" (Lu et al., 2008, p. 366). Institutions are defined as the rules of the game in a society that provide stability, reduce uncertainty and alleviate information complexity in economic exchanges, and they have both formal and informal dimensions (North, 1990). Formal institutions are explicitly created structures, comprising constitutions, laws, regulations, property rights and contracts. These humanly devised constraints structure the way in which organizations (e.g. political bodies, economic agents and social actors) interact with each other and adapt to changing environments by making strategic choices such as compliance, cooperation and defiance (Oliver, 1997). Formal institutions are significant to innovation as they can produce incentives for or barriers to innovation (Edquist, 2006).

First of all, firms are deeply embedded in institutions and their innovative activities are constrained by formal institutions (Edquist, 2006). Formal institutions define patterns of behaviour, shape interactions among economic agents within or across industries and contribute to the development of innovation infrastructure, including the science and technology base and the knowledge and talent pool (Dunning and Lundan,

2008). Firms subscribe to formal institutions and develop their own strategies, including innovation strategies accordingly.

In addition knowledge development, the result of innovation, must be congruent with institutional requirements. Institutional requirements encourage certain behaviour but restrict others (Lu et al., 2008). For example, the reform of China's science and technology system in the 1980s and 1990s was dominated by the overriding concern of policymakers that emphasized the integration of research and production; as a result, a firm's innovation and creative activities focused more on the exploitation rather than the exploration of knowledge (Baark, 2007).

Further, the efficiency and effectiveness of innovations are affected by institutions (Lu et al., 2008). Weak institutions, defined as those that undermine the functioning of the market mechanism, wipe out or reduce firms' incentives for innovation for a number of reasons (Lipczynski et al., 2009; Trevino et al., 2008). Firms cannot fully appropriate the income from their innovation, for example due to the weakness of IPR protection. Firms face significant external limits, for example unsupportive/inefficient governmental services, poor execution of laws and regulations and the shortage of technicians and engineers. Weak institutions therefore raise the costs and reduce the efficiency of innovation. Conversely, well-established and efficient institutions make it easy to access information and provide adequate and high-quality resources and services for innovation by securing the implementation of laws and regulations, protecting IPR, stimulating competition, improving communication and building networks between economic agents (Dunning and Lundan, 2008). They alter the structure of incentives for innovation and direct businesses towards more economically productive activities.

Empirical studies on the role of formal institutions in innovation in China are limited. Zhu et al. (2012) interviewed 82 top managers in 41 Chinese SMEs and found that certain formal institutional barriers including public support, property rights and external technological services affect both the costs and opportunities of innovation and matter significantly in the innovation activities of SMEs in China.

3.2.3 The Role of Formal Institutions in FDI Spillovers

In addition to their direct impact on innovation, formal institutions have an indirect role to play by affecting the extent of FDI spillover effects on innovation. First of all, institutions are seen as an important location advantage of the host countries which attract FDI inflows (Bevan et al., 2004). Formal institutions ensure transparent regulatory regimes and protect property rights (Meyer et al., 2009). Formal institutions can also legitimize the market in host countries making them attractive for foreign investment (Trevino et al., 2008). Within the innovation-promoted institutions, firms, R&D institutions, financial institutions, governments and other types of economic and social agents interact with each other for the purpose of facilitating learning, acquiring information and promoting innovations (Gachino, 2006). MNEs embedded in such an institutional environment may transfer more technologies and knowledge to local subsidiaries and undertake more innovative activities locally, thus increasing the scope for potential FDI spillover effects (Papageorgiadis et al., 2013).

In addition, strong institutions support the effective functioning of market mechanisms and reduce transaction costs of business operations. Where formal institutions are more developed, resources are directed to the “right” economic agents, which accelerates linkages between foreign and domestic firms and facilitates positive FDI spillovers and mitigates negative FDI

spillovers. On the other hand, weak institutions magnify information asymmetries so that firms face high risks and need to spend more resources in the search for information (North, 1993). Knowledge transfer and local innovation may be costly and risky for MNEs; which may reduce the amount of knowledge transferred to local subsidiaries and hinder local innovative activities. In other words, with a weak institutional environment, the knowledge pool that has the potential for FDI spillover effects is limited; therefore weak institutions negatively affect the potential positive FDI spillover effects. Indigenous firm can be enabled by the weak institutions to 'steal' knowledge and technologies from foreign firms. Thus the weak institutions might look good for innovation by indigenous firms in the first instance, but indigenous firms face a much smaller knowledge pool in a weak institutional environment than in a strong one, and consequently benefit less from potential positive FDI spillover effects than they can otherwise. Furthermore, weak institutions provide indigenous firms with fewer instruments to deal with the negative FDI spillovers.

Further, FDI affects innovation performance of indigenous firms through certain channels including demonstration effects, training effects, linkage effects and competition effects (Cheung and Lin, 2004; Chen and Mohnen, 2009; Lin and Lin, 2010), while formal institutions may affect the extent of FDI spillovers through affecting the above channels. Governments provide different levels of assistance, support, information and R&D services to indigenous firms which may affect their capabilities of absorbing and using demonstration effects, training effects and linkage effects from FDI. In a strong formal institutional environment, foreign firms' property rights can be protected and their returns from R&D can be protected by the strong enforcement of the legal system; therefore, they may be willing to do R&D locally (Meyer et al., 2009). Also, with strong formal institutions, governments will provide adequate and high-quality assistance and services

to firms regarding the product development and product market, which may enhance indigenous firms' absorbing capacity when facing FDI spillovers. To the contrary, in a poor formal institutional environment, foreign investors' interests and rights are not well protected; rather, a large number of illegal imitations and violations of property rights may happen and, as a result, they are unwilling to do R&D locally. Also, with a weak formal institutions, governments have poor efficiency and cannot support firms with their R&D and in interacting with foreign firms, consequently, indigenous firms may well not enjoy the demonstration effects, linkage effects and training effects.

3.2.4 Other Determinants of Innovation

There is ample research on the determinants of innovation. The existing literature identifies the following variables as key determinants: R&D expenditure, R&D personnel, exports and competition (Fu, 2008; Gachino, 2006; Liu and Buck, 2007; Lundvall, 2007). R&D expenditure and R&D personnel are major inputs into innovation. R&D expenditure reflects firms' commitment to develop new knowledge, create sophisticated and improved products and services, and advance new processes through applying existing technological stock and embracing technologies created by others. R&D personnel embody human capital that is the essential ingredient for innovation. Firms need human capital pertaining to skills and knowledge to create new products or process ideas. R&D expenditure and R&D personnel play a dual role in the innovation process: developing innovations and enhancing the learning capacity of firms which further enhance innovation development (Liu and Zou, 2008). Several empirical studies find a positive and significant relationship between R&D expenditure and indigenous firms' innovation in China (Fu, 2008; Girma et al., 2008; Wang and Kafouros, 2009). The number of R&D personnel (scientists and technicians) employed

is also found to have a positive and significant impact on innovation in a number of studies (Cheung and Lin, 2004; Fu, 2008; Liu and Buck, 2007).

Export is also recognized as a significant factor, improving the innovation performance of firms (Cheung and Lin, 2004; Girma et al., 2008; Girma et al., 2009; Liu and Buck, 2007; Liu and Zou, 2008; Sun and Du, 2010; Wang and Kafouros, 2009). Supplying export markets generates two main benefits for innovation. Exports expose firms to international markets which are more competitive than domestic markets. This 'pushes' firms to innovate in order to improve their competitiveness. In addition, international exposure provides firms with opportunities to access information and knowledge, and maybe even technological assistance and support from exporting partners. This can directly affect firms' efforts to launch new products or patents.

Competition is another variable that can significantly influence the innovative performance of firms. To defend market share, firms increase their innovative efforts to counter competition (Brambilla et al., 2009). However, competition may also reduce the incentives to innovate as firms are less able to extract the income from innovation or they may reduce in-hour innovation, but undertake imitation or licensing to acquire external R&D. This happens especially when they operate in a country where the intellectual property protection mechanism is not advanced (Dunning and Lundan, 2008).

3.3 Data and Methodology

3.3.1 Data

The main data source used for this chapter is the *World Bank Enterprise Survey* (WBES) on Chinese firms in 2003[4,5,6]. The survey was completed in collaboration with the Chinese National Bureau of Statistics and is part of a larger World Bank project aimed at studying the investment climate and business environment at the firm level in a range of countries. The Chinese dataset covers 18 cities[7] and 6 major manufacturing industries[8]. Detailed questions were asked regarding ownership structure, input, output, production, exports, foreign involvement, institutions and innovation activities. The data span was 2000-2002 for some variables, e.g. input, output, production, exports and innovation activities. However, firms were interviewed once in 2003, so for some questions the answers cover the information for the entire 3-year period.

This dataset has the characteristics of representativeness and reliability. Stratified sampling techniques were used to ensure a good representation of the population of firms in chosen locations and industries. In addition, private contractors were employed to collect data via face-to-face interviews with the accountants/personnel managers of firms and the senior managers of main production facilities to ensure data reliability.

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[4] There are also *2002 and 2005 WBESs* on Chinese enterprises. However, different questionnaires were used in those two surveys and they do not contain many of the variables under investigation in this chapter, e.g. government assistance, R&D services, property rights protection; therefore they are not used.

[5] The new *2012 WBES* does not contain many of the variables under investigation in this chapter including patents, government assistance, property rights protection, R&D services and number of competitors; therefore it is not used.

[6] This dataset has been used in previous research such as that of Brambilla et al. (2009); Cull and Xu (2005) and Lin et al. (2010).

[7] They are Benxi, Changchun, Changsha, Chongqing, Dalian, Guiyang, Harbin, Hangzhou, Jiangmen, Kunming, Lanzhou, Nanchang, Nanning, Shenzhen, Wenzhou, Wuhan, Xian, and Zhengzhou.

[8] They are garments, electronics, food, vehicles and vehicle parts, metals and machinery, and chemicals and pharmaceuticals.

Information on FDI variables measured at the industry level was obtained from the *China Statistics Yearbook on Science and Technology 2000-2002*. All variables in monetary form are deflated by using producer price indices (base year is defined as 1998 = 100) from the *China Statistics Yearbook*. The combination of firm-level and industry-level data allows for in-depth empirical analysis. *WBES 2003* includes 2,400 firms, of which 1,609 are in manufacturing. As this research focuses on indigenous firms' innovation, 158 foreign firms are excluded[9], which finally leaves 1451 firms to be used in estimation. I checked the dataset for missing values and outliers.

3.3.2 Variable Measurement

The measurements of innovation are important. Measures used in the existing literature typically involve one of three major aspects of the innovative process: input measures (e.g. R&D expenditure), intermediate output measures (e.g. patents) or direct output measures (e.g. new product sales) (Acs et al., 2002). As an input measure, R&D expenditure cannot measure the 'efficiency' of knowledge development. An increase in spending on R&D does not imply an increase in firms' innovation output. Patents are considered a good indicator of innovation (Acs et al., 2002). However, they cannot capture market acceptance of innovation outcomes and those innovations that are not patented are excluded from patent data (Liu and Buck, 2007). New product sales indicate market acceptance of new products, which may also reflect innovations that are not patented (Liu and Buck, 2007). However, new product sales, like patents, do not differentiate product and process innovation. Product innovation reflects a firm's status in new products or new business line development while process innovation

[9] Firms were asked whether they are subsidiaries/divisions of multinational firms or joint ventures of multinational firms.

reflects a firm's status in new processes, new management techniques and new quality control development (Lin et al., 2010). It is important to understand which variables have a discriminatory effect between product and process innovation.

In order to achieve a comprehensive understanding of innovation, this chapter uses a range of variables related to new products, patents and the types of innovation engaged in by firms to mitigate the deficiencies inherent in any particular variable. Furthermore, existing studies on innovation often investigate innovating firms only. This excludes a crucial part of the innovation decision, that is, the probability of innovation (whether firms decide to innovate at all). Therefore six measures are employed in total. Two are associated with new products: the probability of developing new products (PNP) (i.e. whether firms introduced new products or services in existing business lines, with 1 indicating yes and 0 indicating no) and the logarithm transformation of the volume of new product sales (NPS). Two are associated with patents: the probability of patenting (PP) (i.e. whether firms acquired patents with 1 indicating yes and 0 indicating no) and the number of patents granted to the firm (PG). With regard to the types of innovation, firms were asked whether they introduced new products or services in existing business lines, entered new business line, undertook new process improvement, developed new management techniques or carried out new quality controls in production with 1 indicating yes and 0 indicating no. To separate product innovation and process innovation, following Lin et al. (2010), the answers to the first two questions are used to identify whether firms engaged in new product innovation (NPdI), while those to the last three questions are employed to ascertain whether they undertook process innovation (NPcI). This is necessary as process innovation is an important part of a firm's innovation performance besides product innovation. Milling and Stumpfe (2000) indicate that there are interdependencies between

process and product innovations. The former is essential for the generation of the latter and manufacturing firms should develop strategies to coordinate product and process innovations. Kraft (1990) also shows that where more product innovations are associated with more process innovations, firms can learn and improve the manufacturing process while making product innovations.

The primary independent variables of interest are FDI and formal institutions. The FDI variable is measured by the share of foreign firms' R&D expenditure in the industry's total R&D expenditure, following Liu and Buck (2007). A one-year lagged FDI variable is used in the estimation to mitigate the endogeneity effect.

Existing studies on institutions tend to use country-level indicators to measure institutions (Bénassy-Quéré et al., 2007; Meyer et al., 2009). However, such measures may not be the best option when investigating firm-level activities. Firms may face the same institutions but experience different degrees of impact in practice, and they may also perceive them differently. Firm-perceived measures can be advantageous as it is the perceptions of decision-makers towards their business environment which may affect the decision-making process significantly (Santangelo and Meyer, 2011). Perception-based indicators are useful because they can be adopted to capture the different aspects of an institutional environment which are difficult to measure objectively. Perception-based indicators are informative because they suggest how firms experience institutional impact (Kaplan and Pathania, 2010). There are a number of existing studies that use firm-perceived indicators and indicate significant implications. Puck et al. (2008) use firm-perceived indicators of the business environment in China and study the entry-mode conversion of foreign-invested firms. Herrera-Echeverri et al. (2013) use firm-perceived indicators of institutional

quality and economic freedom in 87 countries and investigate their relationship with entrepreneurship in emerging countries.

The use of survey data such as questionnaires and interviews may cause the common method bias which may deflate or inflate the correlations between variables as the questions of surveys are normally responded by only one respondent in a firm. However, the common method bias can be reduced in this thesis because the dependent and independent variables are not provided by a single respondent. The World Bank employs private contractors to do face-to-face interviews with multiple respondents including senior managers and corporate owners, the accountants and personnel managers as well as the production and facility managers and ask them questions regarding the business environment and institutional impact.

Formal institutions have several components; however, our dataset only allows us to reflect three main components of formal institutions, namely, the legal system, government assistance and R&D services. These three components are reflected using relevant questions asked of firms in *WBES 2003*. As shown by Tang and Hussler (2011), China has tried to build institutions to catalyse innovation and develop a comprehensive legal system including property rights protection, provide assistance to launch R&D programs, develop universities and research institutes and promote interactions between actors of innovation. These three components of formal institutions are as follows:

1. The legal system is one of the most important components of formal institutions especially with respect to property rights protection (Dunning and Lundan, 2008; Lin et al., 2010). Property rights protection in a country positively affects the innovation performance of its firms (Allred and Swan, 2005; Allred and Park, 2007). Zhu et al. (2012) interviewed 82 top

managers and owners at 41 Chinese SMEs and find that the weakness of property rights protection has become one of the institutional barriers to innovation in China. Following Lin et al. (2010), I use the question "What is the likelihood that the legal system will uphold my contract and property rights in business disputes?" in *WBES 2003* to capture the legal institutions (LAW).

2. The second measure employed to capture different dimensions of institutions is government assistance. North (1990) indicates that government policies reflect the formal institutional framework of a country. Dunning and Lundan (2008) uphold the view that government policies and government support reflect a country's institutional framework and can have a significant impact on firms' performance, as government assistance is an indication of government policies. Zhu et al. (2012) also treat government support as part of institutions and show that government support can affect the innovation of firms significantly. Fan (2006) uses a case study approach to examine four Chinese firms that produce telecoms equipment – Huawei, ZTE, DTT and GDT – and finds the significance of government assistance in their innovation. In *WBES 2003*, firms were asked "During the year 2002 did any government agency or official assist you in identifying foreign investors, locating foreign technology to license, identifying potential foreign clients, identifying potential foreign suppliers, obtaining bank financing and identifying potential domestic clients" with 1 indicating yes and 0 indicating no. Answers to these questions are combined together as a composite measure to reflect government assistance (GOA).

3. Edquist (2006) indicates that, in addition to governments, R&D support provided by R&D institutions of a country also reflects institutional support, and such R&D support can heavily affect firms' innovation in that country. Zhu et al. (2012) show that as part of institution-based barriers, the lack of

linkage with public R&D institutions, deficiencies in the availability of external services and the lack of information on technologies and R&D produce a significant impact on the cost, risk and opportunity relating to innovation in China. Fan (2006) suggests that a firm's in-house innovation should be supplemented with external support. To apprehend this aspect of institutions, I employ the questions related to the level of availability, affordability and quality of R&D services (RDS). Firms were asked to evaluate, on a 1-4 scale, the level of availability, affordability and quality of R&D services (RDS). Again, answers to these questions are combined together as a composite measure.

A number of control variables are included in the estimation. R&D expenditure (RDE) is measured by the ratio of R&D expenditure to total sales. R&D personnel (RDP) is the number of people engaged in R&D. Exports (EXP) are the log transformation of exports. The number of major competitors within the main business lines in the indigenous market is used to capture the level of competition (COM).

Finally, a number of dummies are also incorporated in the regressions. City dummies are used to control for location specific effects. Variations in firm innovation may be associated with the industry to which firms belong. High-tech industries tend to be more innovative than low-tech industries. The technology intensity dummies, based on the 2011 Technology Intensity Definition of the Organization for Economic Co-operation and Development (OECD), are built to control industry-specific effects. Firms' main business lines are used for the industry classification.

3.3.3 Estimation Methods

As shown by Du et al. (2007), it is advantageous to consider whether firms decide to innovate, and which type and the amount of innovations that they undertake. Therefore, I investigate the following innovations by firms. Whether to innovate or not (PNP and PP) is estimated by using Logit models. NPS is estimated by using the Tobit model[10], PG the negative binomial model[11] and NPdI/NPcI the ordered logistic model[12]. I use robust errors for the heteroscedasticity issue.

[10] As data for NPS is left-censored at zero and the distribution of the sample is a mixture of discrete and continuous distributions, Tobit model is appropriate.

[11] Given the non-negative and discrete nature, Patent follows Poisson distribution. However, because a large number of data take zero value, to allow for 'overdispersion' into the data, the negative binomial model is used. This produces improved efficiency in estimations.

[12] This is because all three variables are ordered variables.

Table 3 Explanation of Variables

Dependent Variables (Firms' Innovation)	PNP	Probability of Developing New Products	FDI Variable	FDI	Foreign Direct Investment
	PP	Probability of Patenting	Moderation Variables	GOAxFDI	Interaction between GOA and FDI
	NPS	Volume of New Product Sales		LAWxFDI	Interaction between LAW and FDI
	PG	Number of Patents Granted		RDSxFDI	Interaction between RDS and FDI
	NPdI	Whether Firms Engaged in New Product Innovation	Control Variables	RDE	R&D Expenditure
	NPcI	Whether Firms Undertook New Process Innovation		RDP	R&D Personnel
Institution Variables	GOA	Government Assistance		EXP	Exports
	LAW	Legal Institutions		COM	Competition
	RDS	R&D Services			

Table 4 Sample Statistics and Correlation Analysis

Variable	Mean	s.d.	7.	8.	9.	10.	11.	12.	13.
1. PNP	0.831	0.375							
2. PP	0.138	0.345							
3. NPS	7.246	3.911							
4. PG	0.391	2.063							
5. NPdI	0.734	0.828							
6. NPcI	1.639	1.229							
7. FDI	0.245	0.122							
8. GOA	0.793	1.286	0.084						
9. LAW	64.749	37.900	0.020	0.095					
10. RDS	1.816	2.336	0.093	0.262	0.103				
11. RDE	2.531	26.515	0.084	0.240	0.078	0.267			
12. RDP	27.919	148.657	0.066	0.292	0.082	0.332	0.626		
13. EXP	1.677	3.625	0.150	0.090	0.051	0.047	0.109	0.158	
14. COM	3.753	1.308	-0.035	-0.118	0.010	-0.126	-0.273	-0.311	-0.037

For all regressions, multicollinearity is checked by using Spearman correlation coefficients. No pair of the independent variables is highly correlated except institution variables and their interaction terms with FDI. The high correlations between three institution variables and their interaction terms with FDI cause multicolinerity problem which is suggested by both Spearman test and VIF test. I have tried the 'mean-centred' method to deal with the highly-correlated variables, however, it didn't work. I therefore do not include formal institutions variables when interaction variables between formal institutions and FDI are used. However, I do realize that the findings from the moderation effects are restricted when I drop the original institutional variables because the indirect effects of formal institutions on innovation of firms through FDI cannot be well tested in this case, which forms a limitation of the thesis and I have already acknowledged this as one of the limitations in the chapter 6.

3.4 Results

Table 5 presents the estimation results that include FDI spillovers (FDI), formal institution variables (LAW/GOA/RDS) and control variables (RDE/RDP/EXP/COM).

Table 5 Role of FDI and Formal Institutions in Innovation

	Logit Model	Logit Model	Tobit Model	Negative Binomial Model	Ordered Logistic Model	Ordered Logistic Model
	PNP	PP	NPS	PG	NPdI	NPcI
FDI	0.552	-4.590***	2.586	-8.652***	-0.618	-1.247
	[1.196]	[1.023]	[2.065]	[1.636]	[0.632]	[0.568]
LAW	-0.002	0.002	-0.001	0.004**	0.005***	0.001
	[0.002]	[0.002]	[0.003]	[0.002]	[0.001]	[0.001]
GOA	0.090*	0.181***	0.289***	0.105*	0.179***	0.250***
	[0.054]	[0.036]	[0.072]	[0.056]	[0.029]	[0.030]
RDS	0.019	0.121***	0.170***	0.115***	0.163***	0.174***
	[0.030]	[0.025]	[0.046]	[0.042]	[0.016]	[0.015]
RDE	0.003	-0.001	0.005***	0.002	0.006**	0.000
	[0.002]	[0.002]	[0.002]	[0.003]	[0.003]	[0.000]
RDP	0.014***	0.003**	0.003***	0.006***	0.002***	0.002***
	[0.004]	[0.001]	[0.001]	[0.001]	[0.000]	[0.001]
EXP	-0.025	0.037**	0.080**	0.067***	0.006	0.036***
	[0.023]	[0.017]	[0.034]	[0.020]	[0.010]	[0.011]
COM	-0.066	-0.321***	-0.439***	-0.579***	-0.150***	-0.175***
	[0.057]	[0.044]	[0.085]	[0.058]	[0.028]	[0.028]
N	1612	3304	1562	3304	3339	3330
R^2	0.076	0.159	0.032	0.100	0.109	0.076

City and industry dummies are included in the estimation. Robust standard errors are in parentheses. 'N' is the number of observations. ***, ** and * indicate that the coefficient is significantly different from zero at the 1%, 5% and 10% levels respectively.

In terms of the impact of FDI on innovation, it is clear that FDI produces significant and negative effects on patents, both the probability of patenting (PP) and the number of patents granted (PG) and negative, albeit statistically insignificant, effects on the types of innovation (NPdI/NPcI). The impact on the probability of developing new products (PNP) and new product sales (NPS) is statistically insignificant. These results indicate that innovation by Chinese indigenous firms is not affected or negatively affected by FDI spillovers.

Among the three formal institutional factors, the law institutions (LAW) generates a significant and positive effect on PG and NPdI only.

Government assistance (GOA) has a positive and significant impact on all the innovation measures. R&D services (RDS) produce a significant and positive effect on all the innovation measures except PNP. These results provide strong support that formal institutions influence innovation by Chinese indigenous firms.

Table 5 also clearly shows the importance of control variables in determining a firm's innovative activities. R&D expenditure (RDE) significantly and positively influences NPS and NPdI. The number of R&D personnel (RDP) produces a significant and positive effect on all aspects of innovation. Exports (EXP) generate significant and positive effects on all aspects of innovation except PNP and NPdI. Finally, competition (COM) generates consistently negative effects on almost all aspects of innovation.

To control for multicollinearity between formal institution variables and their interaction terms with FDI, table 6 presents the results that include the interaction terms but not the formal institution variables.

Table 6 Moderation Effects of Formal Institutions on FDI Spillovers

	Logit Model	Logit Model	Tobit Model	Negative Binomial Model	Ordered Logistic Model	Ordered Logistic Model
	PNP	PP	NPS	PG	NPdI	NPcI
FDI	0.925	-7.063***	0.213	-10.886***	-3.292***	-3.058***
	[1.278]	[1.067]	[2.191]	[1.660]	[0.679]	[0.598]
LAW x FDI	-0.011	0.009	-0.004	0.020**	0.017***	0.004
	[0.007]	[0.006]	[0.011]	[0.009]	[0.004]	[0.003]
GOA x FDI	0.297	0.734***	1.028***	0.443**	0.492***	0.596***
	[0.195]	[0.127]	[0.265]	[0.209]	[0.099]	[0.106]
RDS x FDI	-0.022	0.338***	0.455***	0.286*	0.449***	0.516***
	[0.107]	[0.087]	[0.170]	[0.160]	[0.058]	[0.057]
RDE	0.003	-0.000	0.005**	0.002	0.006**	-0.000
	[0.003]	[0.001]	[0.002]	[0.004]	[0.003]	[0.000]
RDP	0.014***	0.003**	0.003***	0.006***	0.002***	0.002***
	[0.004]	[0.001]	[0.001]	[0.001]	[0.000]	[0.001]
EXP	-0.026	0.038**	0.083**	0.071***	0.007	0.036***
	[0.023]	[0.017]	[0.034]	[0.020]	[0.010]	[0.010]
COM	-0.074	-0.328***	-0.437***	-0.579***	-0.154***	-0.182***
	[0.057]	[0.044]	[0.086]	[0.057]	[0.028]	[0.028]
N	1612	3304	1562	3304	3339	3330
R^2	0.075	0.157	0.031	0.099	0.097	0.065

City and industry dummies are included in the estimation. Robust standard errors are in parentheses. 'N' is the number of observations. ***, ** and * indicate that the coefficient is significantly different from zero at the 1%, 5% and 10% levels respectively.

It is found that FDI continues to generate negative effects on those aspects of innovation including patents (PP and PG) and types of innovation (NPdI and NPcI), but this time those negative effects on types of innovation (NPdI/NPcI) become statistically significant. Its impact on new product sales, both in terms of probability and volume, remains statistically insignificant. The negative FDI spillover effects are clearly moderated by

institution factors. The legal institutions (LAW) play a positive moderating role in patents granted (PG) and different types of product innovation. Government assistance (GOA) plays a positive moderating role in all innovation categories except for the probability of developing new products (PNP). R&D services (RDS) similarly has significant moderation effects on FDI spillovers except in the PNP model. Together the above results indicate that formal institutions positively moderate the extent of FDI spillover effects on innovation by Chinese indigenous firms.

3.5 Discussions and Implications

The discussion starts with the direct impact of formal institutions on innovation, followed by FDI spillovers and the role of formal institutions in the process.

The formal institutional factors have a significant impact on firms' innovation by producing incentives for or barriers to innovation. First of all, the legal institutions (protection of property rights in this case) are shown to promote the number of patents granted and the variety of new product innovation. This finding lends empirical support to theoretical arguments made in the existing literature. For example, North (1990) considers property rights to be a key to channelling resources towards productive investments. Dunning and Lundan (2008) regard IPR enforcement as the most critical part of the institutional structure of host countries in promoting knowledge transfers and attracting innovative activities of MNEs. Since opening up, China has made lots of improvements in recognizing property rights and implementing laws and regulations governing property rights protection. Although there are still gaps with the advanced economies, China is actively involved in many significant international conventions

regarding property rights protection such as the Agreement on Trade-related Aspects of Intellectual Property Rights (TRIPS) (Newberry, 2002). These international conventions require China to connect its IPR legislation and enforcement to the fundamental requirements of international codes of conduct, which leads China to modify its current legal system and regulatory framework. The findings show that such efforts have borne fruit. The number of patents granted to indigenous manufacturing firms in China is positively affected by the property rights protection. However, on the other hand, China is still not robust and efficient at enforcing compliance with TRIPS. The legal system in China is not effective and efficient in promoting new product sales and new process innovation, in contrast to its positive role in promoting the patents granted to Chinese manufacturing firms. The protection of patents and trademarks is important as they are economically valuable assets for both indigenous and foreign investors, especially those technology-intensive and internationally-focused firms (Kogan, 2006). At the same time, the protection of new products and new processes should not be overlooked. Therefore, as a general policy, besides the patents, the legal protection should also be focused on the new products in the market and the new process innovation of firms in order to protect those innovations that are not patented. This is of paramount importance to China as a large number of Chinese firms still rely heavily on imitating new products rather than making critical innovations (Brambilla et al., 2009). The illegal imitation and violation of property rights are prevalent in China, which bring risks to innovators. To change the scene, Chinese governments should strengthen law enforcement, promote innovation and limit imitations. In the meantime, Chinese firms should enhance their awareness of the law and use the weapon of the law to protect their interests and returns from R&D. Firms should therefore apply for patents and trademarks in time, and they should also be informed of the possible illegal imitators or counterfeit producers in the product market. Moreover, innovative Chinese firms should

work closely with government departments such as the patent office to detect illegal imitation and violations of property rights in order to protect their interests in time, reduce the risks and enhance the efficiency of legal protection.

In addition, the Chinese governments at various levels exert greater influence than their counterparts in many advanced economies in affecting innovation at national, industrial and firm levels. Governments play an important role in providing assistance, including making supportive policies, allocating resources (Lu et al., 2008) and building links between economic agents of innovation (e.g. firms, universities, research institutions and financial institutions) (Gu et al., 2009). The findings suggest more assistance from government helps facilitate firms to consider patent applications, though not necessarily get more patents granted. Government assistance also helps to generate more product innovations and process innovations and integrate innovation with production. Government assistance can take various forms. Rothwell and Zegveld (1982) suggest that tax concessions, entrepreneurial education, networks of industrial research organizations, and technical and information services are important to innovation. Zhu et al. (2012) argue that the quality of government support can affect firms' innovations in China significantly. Chinese governments should therefore provide firms with adequate and high-quality support and services to assist their innovation. Firms, on the other hand, should be informed of what resources and support are available from governments and pay close attention to the policy trends and dynamics.

One practical example is the '1000-100-10 Initiative' issued by the Ministry of Commerce in 2006. It aims to foster the growth of high-tech and clean industries. China initially designated 10 demonstrating cities to attract 100 famous multinational firms and train 1000 medium-sized indigenous firms

in outsourcing and software industries. This initiative was then extended to 22 cities (Wright, 2009). Chinese governments at national, province and city levels are offering taxation benefits, financial support and human resource backups to both local and foreign firms engaged in this initiative. As a result, a large number of local firms in these cities are now actively engaging into high-tech outsourcing industries and the local infrastructure associated with this has also been upgraded. The local IPR protection has witnessed improvements and the number of R&D centres in local regions have also increased. All of the above contribute to the innovation of indigenous firms (Wright, 2009).

Further, innovation of indigenous Chinese manufacturing firms is positively affected by R&D services. The quality, availability and affordability of R&D services can influence firms' innovation because R&D services are the media of knowledge and technological information which are the keys to innovation. Moreover, formal institutional settings affect firm behaviour by providing resources and opportunity structures, which influence the R&D services available to firms; as a result, innovative capabilities of firms may be different (Breznitz, 2007). Government therefore should provide high-quality and affordable R&D services for firms and provide support to help improve firms' capability of using the R&D services effectively. The R&D services should be made publicly available and accessible for firms. In this regard, removing the funding constraints and providing a combination of international and local services on R&D are an effective means to improving the innovation. In the meantime, for Chinese firms, building links and interacting with universities, foreign and indigenous R&D institutions and government institutions is an effective way of acquiring high-quality R&D services from external sources.

FDI clearly has a negative effect on the patents of indigenous manufacturing firms. This finding is in line with several empirical studies (Chen, 2007; Sun and Du, 2010; Zhang and Rogers, 2009). This in a way demonstrates the degree of competition between MNEs and indigenous Chinese firms is fierce, which negatively affects the latter's innovative efforts and they may be forced to concentrate more on production rather than original research. Because of the focus on the integration between adaptive innovation and production, the positive and negative FDI spillover effects balance each other out, therefore the impact appears to be statistically insignificant on other aspects of innovation.

There are some possible reasons behind the negative innovation effects from FDI. Sinani and Meyer (2004) argue that indigenous firms may lose employees with talent and skills to foreign firms as MNEs normally provide higher salaries and better rewards to lure and retain these employees. This consequently reduces indigenous firms' capabilities in innovation. The increased competition brought by MNEs may reduce the market share of indigenous firms and affect their profitability, which in turn may restrict their capabilities of investing into innovative activities. Du et al. (2008) indicate that firms which cannot meet the new technological challenges may be crowded to the periphery of the industry, as a result, they may be inclined to concentrate on more labour-intensive than technology-intensive products, which in turn gives them lower profitability. Indigenous firms may also heavily depend on foreign technologies brought by MNEs and reduce their own innovation activities. All of the above scenarios may restrict and weaken local firms' innovation.

The positive changes in China's formal institutions help to mitigate the negative innovation effects from FDI. The legal system, government assistance and R&D services all produce significant and positive

moderation effects on FDI spillovers. As a general policy, government can encourage indigenous innovation by building a more formal innovation-supporting institutional framework, and offering strong incentives for local firms to carry on creative innovation, apply patents and integrate product and process innovation with business activities. More specifically towards FDI, government can provide high-quality support for indigenous firms in identifying foreign investors, locating foreign technologies to license, and identifying potential foreign clients/suppliers.

3.6 Conclusion

The existing literature on the role of FDI in the innovation of firms is insufficient to exploit the determinants of innovation. Following the institution-based view, formal institutions should be put in the forefront rather than treated as "background" when investigating innovation of firms (Lu et al., 2008). The institution-based view has been largely neglected when studying the innovation performance of firms, especially when we put the research context in China where there is a strong institutional impact on firms (Dunning and Lundan, 2008). In this chapter, building on the institution-based view, formal institutions are integrated into the analytical framework in order to investigate their role in affecting innovation and moderating FDI spillovers. It explores three aspects of formal institutions, namely, government assistance, property rights protection and R&D services. This empirical study is one of the first attempts to bring the formal institutions from a background factor to the forefront and empirically investigate formal institutions' impact on innovation by using firm-level data on China's manufacturing firms. Moreover, among the first attempts, this thesis extends the literature of FDI spillover effects through investigating the role of formal institutions in FDI spillovers.

The findings indicate that FDI produces negative effects on patents of Chinese manufacturing firms. In contrast, formal institutional factors including the legal system, government assistance and R&D infrastructure produce significant and positive effects on innovation. They also moderate the negative FDI spillover effects.

The empirical results have significant managerial and policy implications. The number of patents granted to indigenous manufacturing firms in China is positively affected by the property rights protection. However, the study also finds that the legal system in China is not effective and efficient in promoting the new product sales and the new process innovation in contrast to its positive role in promoting the patents granted to Chinese manufacturing firms. The protection of new products and new processes should not be overlooked. Therefore, as a general policy, besides the patents, the legal protection should also be focused on the new products in the market and the new process innovation of firms in order to protect those innovations that are not patented. Chinese governments should strengthen law enforcement, promote innovation and limit imitations. In the meantime, Chinese firms should enhance their awareness of law and use the 'weapon' of law to protect their interests and returns from R&D.

The findings suggest more assistance from government will help facilitate firms to consider patent applications and new product sales. It can also help to generate more product innovations and process innovations. Chinese governments should therefore provide firms with adequate and high-quality support and services to assist their innovation. Firms, on the other hand, should be informed of what resources and support are available from governments and pay close attention to the policy trends and dynamics.

Innovation of indigenous Chinese manufacturing firms is positively affected by R&D services. Government therefore should provide high-quality and affordable R&D services for firms and provide support to help improve firms' capability of using the R&D services effectively. The R&D services should be made publicly available and accessible for firms. In the meantime, for Chinese firms, building links and interacting with universities, foreign and indigenous R&D institutions and government institutions is an effective way of acquiring high-quality R&D services from external sources.

The positive changes in China's formal institutions help to mitigate the negative innovation effects from FDI. As a general policy, government can encourage indigenous innovation by building a more formal innovation-supporting institutional framework, and offering strong incentives for local firms to carry on creative innovation, apply patents and integrate product and process innovation with business activities.

Chapter 4: The Role of Regional Formal Institutions and FDI in Innovation

4.1 Introduction

In the previous chapter, the thesis indicated the impact of FDI on the innovation of Chinese manufacturing firms and it suggests that FDI produces a negative effect on the patents granted to firms. Meanwhile, based on the institution-based view (refer to sections 3.1 and 3.2.2), the thesis has also investigated the role of firm-perceived formal institutions in the innovation of Chinese manufacturing firms and it reveals that firm-perceived formal institutions in China (reflected by government assistance, property rights protection and R&D services) play a positive role in the innovation of firms directly, and through affecting FDI spillover effects indirectly. As the engine of economic development, the determinants of innovation still require further exploration. Existing studies on formal institutions tend to focus on the national institutions (Edquist, 2006; Lu et al., 2008); however, the diversities across regions within a single country cannot be overlooked. Regional institutions are the capacities of a region to coordinate institutional framework and infrastructure (Parker and Tamaschke, 2005). They are geography- and context specific (Rodríguez-Pose, 2013). Different regions tend to have different regional formal institutions (Asheim et al., 2011). This is especially true when it comes to a large emerging economy like China. Liu et al. (2014) suggest that large emerging economies feature by high degrees of income inequality, regional disparity and regional institutional diversity. China presents a rich context to investigate the role of regional formal institutions in innovation due to its variation in institutional frameworks across regions. With more

than 30 provinces, China is widely known for its diverse regional institutions and regional disparity (Liu et al., 2014). All of the above reminds me to look into the impact of China's institutions at the regional level. With disparities in institutional development across regions, Chinese firms and regions tend to have different levels of innovation as the costs, risks and incentives of firms in innovation are affected by the regional institutional building. However, among the prior literature, none investigates the role of regional institutions in firms' innovation and in regions' innovation, and their important impact is under-explored. In order to fill the research gap, this chapter examines five main aspects of regional formal institutions including government support, legal institutions, financial institutions, educational institutions and taxation institutions in the innovation of Chinese manufacturing firms and in the innovation of regions in China.

This chapter addresses two major research questions. First, what is the role of regional institutions in the innovation of Chinese manufacturing firms? Second, what is the role of regional institutions in the innovation of regions in China? I propose that both indigenous firms' innovations and regional innovations are influenced by FDI spillovers and regional formal institutions.

Below, Section 4.2 reviews the existing literature regarding FDI spillover effects, regional formal institutions and their role in innovation. This is followed by a discussion of data, variables and methodology in section 4.3. Section 4.4 provides empirical findings, and section 4.5 provides a discussion and implications. Finally, section 6 concludes the chapter.

4.2 Literature Review

4.2.1 FDI Spillovers and Innovation

In addition to the points that I have made in section 3.1 and 3.2.1, FDI can also directly contribute to regional innovation through locating foreign R&D laboratories and generating innovation outputs in local regions. In the era of globalization, a large number of MNEs have set up R&D laboratories in host countries, aiming to provide technological support for their foreign investment and assist their product development in local regions and product introduction to target markets (Fu, 2008). In many cases, given the importance of local markets, MNEs even set up R&D headquarters in host countries, aiming to strengthen their technological dominance and provide powerful technological support for product development in local regions. The outputs generated from R&D and other forms of innovation activities carried out by foreign R&D laboratories and headquarters can directly increase the overall amount of innovation outputs such as patents and new products in local regions, causing growth in regional innovation (Fu, 2008).

4.2.2 Regional Formal Institutions and Innovation

The previous chapter empirically investigated the role of firm-perceived formal institutions in the innovation of Chinese manufacturing firms. In this chapter, in contrast to the firm-perceived formal institutions, I examine the role of formal institutions at the regional level and propose that regional formal institutions affect the innovation of Chinese manufacturing firms and also affect regional innovation.

Different regions tend to have different formal institutions (Asheim et al.,

2011). The capacity of regions to coordinate an institutional framework and infrastructure may vary. Regional institutions interact with national institutions and generate particular patterns of regional institutional framework (Parker and Tamaschke, 2005). Institutions are geography- and context- specific. A strong and efficient institutional framework in one region, does not necessarily mean a strong and efficient institutional framework in another (Rodríguez-Pose, 2013). Rhodes (1995) suggests that the regional development and performance are "connected with differences in their resource endowments and the ways in which these resources are used, and therefore with variations in their institutions and modes of governance, in their approaches to the development of infrastructure and skills and in the economic and development policies they pursue" (p. 180). Development strategies that are tailored specifically to different regional institutions are likely to produce better returns than otherwise (Keune, 2001).

Regional institutions affect firms' innovation. Well-established regional institutions facilitate innovation through providing an efficient infrastructure, initiating supportive policies and allocating resources (Zaheer and McEvily, 1999). Such regional institutions act as substitutes for national support (Liu et al., 2014). In contrast, poor regional institutions hinder innovation by lowering efficiency and increasing costs. First of all, the innovation networks of firms are embedded in and affected by regional institutions as they influence the interactions between players inside the innovation networks (Edquist, 2006; Lundvall, 2007). Within the networks of innovation, regional institutions are designed to build and maintain the mechanism of governing the behaviour of economic agents (Liu et al., 2014). The governing mechanism affects openness, information exchange and knowledge sharing which are fundamental to innovation (Gertler et al, 2002). In addition, strong regional institutions can make "bottom-up" initiatives with the purpose of promoting regional innovation (Keune, 2001).

Strong regional institutions have the advantages of coordinating different policies of innovation closely, creating synergy, making efficient use of resources for innovation, dealing with region-specific problems and building specific regional strengths in innovation (Keune, 2001). Further, strong regional institutions foster innovation through creating conditions for innovation and reducing risks and costs associated with innovation. Moreover, strong regional institutions assist regions to adjust and adapt to changes through generating the 'adaptive efficiency'. This allows firms to acquire new information and knowledge and engage in innovation (Rodríguez-Pose, 2013).

Furthermore, regions with well-established institutions may have effective government institutions, legal institutions, educational institutions, financial institutions and taxation institutions, all of which affect firms' innovation. This is due to the fact that well-established institutions provide policy support deriving from government institutions, adequate channels to finance deriving from financial institutions, protection on innovation outcomes deriving from legal institutions, a stock of talent deriving from educational institutions, and low tax burden and effective use of tax revenue deriving from taxation institutions. Firms operating in such effective regional institutions are able to develop capabilities in innovation with institutional support (Liu et al., 2014). In contrast, regions with ineffective regional institutions may undermine market competition and distort resource allocation with non-market forces. Such ineffectiveness in regional institutions comes from administrative omission, non-execution of laws, shortage of talent, difficulty in financing and a heavy tax burden. Firms operating in such regional institutions may have few incentives and poor capability to innovate (Liu et al., 2014).

More specifically, first of all, government policies reflect the formal institutional framework of a region (North, 1990). A strong and efficient regional government institutions can provide access to adequate and high-quality services, support and information for firms regarding the product development and product market. Also, a strong regional government institutions can provide training for the human resources of firms and financial support for firms' R&D, which are the keys to innovation. Therefore, under this circumstance, firms are likely to witness growth in innovation. In contrast, poor regional government institutions inhibit the effective and efficient generation and delivery of government support and services. R&D and innovation are risky and costly. With poor government support, firms have to rely on themselves to deal with the risky and costly R&D and innovation. Moreover, instead of helping and supporting firms, poor government support may waste firms' time and resources or even involve corruption in looking for such government support. Therefore, firms are unlikely to experience growth in innovation; rather, such institutions will become barriers to firms' innovation (Zhu et al., 2012).

In addition, the legal system is one of the most important aspects of formal institutions (North, 1993). In a region with a strong and efficient legal institutions, firms' outcomes of innovation can be protected and their returns and benefits from innovation can be guaranteed. A strong legal institutions foster innovation through providing incentives to firms and reducing risks and costs of innovation. To the contrary, a weak legal system prohibits innovation because firms have to confront many risks such as illegal imitation and violation of property rights and they have to deal with such risks on their own, which may push up their operating costs, waste their resources and reduce their incentive to innovate.

Further, the capability of absorbing and applying new ideas is important for innovation, and the human resource – one of the keys to innovation – plays an important role in forming such capability (Fu, 2008). Educational institutions affect the development and robustness of the human resource, and it is associated with the supply and maintenance of a skilled human resource (Keune, 2001). The development of educational institutions in a region affects the quality of the human resource and fosters the absorption and application of new ideas (Edquist, 2006). In a region with a strong educational institutions, firms can have access to high-quality and well-trained staff who possess abundant knowledge and skills regarding the product development and product market; therefore, firms' innovation performance can be improved. To the contrary, in a region with poor development of educational institutions, as one of the key elements for innovation, the quality and stock of the human resource is restricted, which may undermine firms' innovation by restricting their capabilities of doing R&D, developing new products, responding to spillover effects, reacting to the market opportunities and competing with rivals.

Moreover, the financial institutions in a region play an essential role in supporting and promoting knowledge generation and transfer, which are at the centre of regional innovation (Edquist, 2006). A region with a robust financial institutions provides multiple, swift, low – cost and efficient channels to finance and help firms raise fund – a fundamental element for innovation. In contrast, a region with an inefficient financial institutions hinder firms' innovation through affecting firms' incentive, speed and capability of doing R&D, developing new products and responding to external innovation opportunities (Zhu et al., 2012).

Last, the taxation institutions are also an indispensable part of formal institutions (Zhu et al., 2012). Tax policies can be either encouraging or

harmful to innovation. Firms in different regions tend to undertake the tax burden to different degrees (Fan et al., 2011). Institutions across regions tend to offer different levels of tax rates and tax incentives to firms (Tung and Cho, 2001). Such differences in the tax burden affect both costs of and opportunities for innovation (Zhu et al., 2012).

4.2.3 Other Determinants of Innovation

The same details have been provided in Chapter 3 under section 3.2.4 on page 55. Therefore I don't repeat it here.

4.3 Methodology

4.3.1 Data

The data sources that I use for this chapter are the *World Bank Enterprise Survey (WBES)*[13] *2012* on Chinese firms, *NERI Marketization Index 2011* and the *China Statistics Yearbook 2011-2012*. I use the *WBES 2012* as the data source for the innovation variables and control variables at the firm level, as it is the latest firm-level dataset on Chinese firms which can reflect the most recent situation of Chinese firms' innovation. I use both *NERI Marketization Index 2011* and *China Statistics Yearbook 2011* as data sources for the regional formal institution variables at the provincial level, while the *China Statistics Yearbook 2011* also serves as the data source for the FDI variable at the industry level. I use the China Statistics Yearbook 2012 as the data source for the regional innovation variables.

[13] Please refer to section 3.3.1 for more features regarding WBES on Chinese firms.

The *WBES 2012* on Chinese firms covers 25 cities[14] and 20 manufacturing industries[15]. The data span is between 2009-2011 for some variables, but it covers only the year 2011 for the rest. However, many questions ask the situation of firms in 2011 but relate to their situation during the past three years, for example, "In the fiscal year 2011, what percentage of this establishment's total annual sales was accounted for by products or services that were introduced in the last three years." The *WBES 2012* includes 2,700 firms, of which 1,692 are manufacturing firms. As this study focuses only on the indigenous manufacturing firms in China, 156 foreign-invested firms are excluded[16], which finally leaves 1,536 firms for estimation. The dataset goes through checks for missing values and outliers.

4.3.2 Variable Measurement

Measurements are important when we try to understand firms' innovation (refer to the section 3.3.2). As the patent data has been removed from *WBES 2012*, unlike in chapter 3, it is not possible to measure innovation using the patent data in this chapter. As in chapter 3, *WBES 2012* allows me to use a range of measures related to new products and the types of innovation that firms engage in to measure innovation of firms. Two variables are associated with new products: the probability of developing new products (PNP) and the ratio of new product sales (NPS) to total sales. The others are associated with the types of innovation that firms engage in: new product innovation (NPdI) and new process innovation (NPcI). Refer to section 3.3.2 for more details of constructing these four variables. *WBES 2012*

[14] They are Hefei, Beijing, Guangzhou, Shenzhen, Foshan, Dongguan, Shijiazhuang, Tangshan, Zhengzhou, Luoyang, Wuhan, Nanjing, Wuxi, Suzhou, Nantong, Shenyang, Dalian, Jinan, Qingdao, Yantai, Shanghai, Chengdu, Hangzhou, Ningbo and Wenzhou.

[15] They are food, tobacco, textiles, garments, leather, wood, paper, recorded media, refined petroleum products, chemicals, plastics and rubber, non metallic mineral products, basic metals, fabricated metal products, machinery and equipment, electronics, precision instruments, transport machines, furniture and recycling.

[16] According to the Company Law and Securities Law in China, a foreign-invested firm involves at least 25% of total shares coming from foreign investors.

allows me to investigate a new innovation variable: the association between a firm's production and the new processes introduced. Firms were asked what percentage of their establishment's annual production volume in 2011 was associated with new or improved processes introduced over the last three years (APPI). Altogether, five measurements are employed to measure the innovation of Chinese manufacturing firms.

For the measurements of regional innovation, I use 'new product sales of a region (RENPS)' and 'the number of patents granted in a region (REPG)'. I also look into the patents granted in a region and use 'invention (INV)', 'utility model (UTM)' and 'external design (EXD)' to measure regional innovation. Therefore, altogether, five measurements are employed to measure regional innovation.

The primary independent variables of interest are FDI and regional formal institutions. As the data on R&D of foreign firms has been removed from the *China Statistics Yearbook on Science and Technology 2011*, unlike what I did in chapter 3, it is not possible to use the R&D of foreign firms to capture industrial FDI in this chapter. Alternatively, the FDI is measured by the log transformation of fixed assets invested by foreign firms. A one-year lagged FDI variable is used in estimations to mitigate the possible endogeneity effect.

Existing studies on institutions tend to use country-level indicators of institutions (Bénassy-Quéré et al., 2007; Meyer et al., 2009). However, such measures may not be the best option because institutional frameworks vary significantly between regions in China. Firms may experience very different institutional impacts across provinces. Based on the discussions in section 4.2.2, regional institutions can be reflected by government institutions, legal institutions, educational institutions, financial institutions and taxation

institutions. As I have done in chapter 3, legal institutions and government institutions are used to measure formal institutions in this chapter. However, unlike in chapter 3, I include three other aspects of formal institutions including educational institutions, financial institutions and taxation institutions which cannot be investigated by using the *WBES 2003* dataset in the previous chapter. In this chapter, I use *NERI Marketization Index 2011* and the *China Statistics Yearbook 2011-2012* to reflect the provincial level formal institutions as follows:

1. I use "the ratio of R&D expenditure by governments to the total R&D expenditure of a region" from the *China Statistics Yearbook 2011* to reflect regional government assistance (GOA).

2. In order to reflect the regional legal institutions, factor analysis is used to produce an indicator of the regional legal institution (LAW) based on "protection of intellectual property rights", "protection of producer rights" and "protection of consumer rights" from *NERI Marketization Index 2011*.

3. I use "number of universities in a province" from the *China Statistics Yearbook 2011* to reflect the regional educational institutions (EDU).

4. I use the "financial marketization" index from *NERI Marketization Index 2011* to reflect regional financial institutions (FMR). This index is produced based on the proportion of non-state-owned financial institutions in accounting for the total amount of capital inflows and outflows, with the higher value meaning the more developed financial institutions in a region.

5. I use "the reduction of tax burden upon firms (TAX)" index from *NERI Marketization Index 2011* to reflect the regional taxation institutions, with the higher value meaning less of a tax burden upon firms. The 'tax burden'

here is the ratio of total amount of tax paid by a firm in the firm's total revenue.

A number of control variables are included in the estimations. R&D expenditure (RDE) is measured by the ratio of R&D expenditure to total sales. As the *WBES 2012* has no data on R&D personnel, I use the number of skilled production workers in the establishment to approximately capture the R&D personnel (RDP). Exports (EXP) is the log transformation of total exports. Due to the large number of 'null' values in the *WBES 2012* regarding the level of competition faced by firms, the firm-level competition variable is therefore not used. Instead, the volume of transactions in the technology market against the number of technological personnel in a region is used to reflect the competition (COM) in innovation faced by firms in a given region.

Finally, a number of dummies are also incorporated in the regressions. City dummies are used to control for location specific effects and industry dummies are employed to control for the variations in different industries.

4.3.3 Estimation Methods

The firms' innovation variables, whether firms introduce new products/services or not (PNP) are estimated by using the Logit model as this variable takes the value "1" or "0". I have also tried Probit model and it produces very similar results. New product sales (NPS) are estimated by using the OLS model as the values take the form of ratios. OLS model is chosen because NPS follows the normal distribution and OLS model is appropriate in this case to estimate NPS as dependent variable (Cameron and Trivedi, 2009; Wooldridge, 2012). In addition, new product innovation (NPdI) and new process innovation (NPcI) are estimated by using the

ordered logistic models[17], and the association between production and new processes introduced (APPI) is estimated by using the OLS model because the variable takes the form of ratios. OLS model is chosen because APPI follows the normal distribution and OLS model is appropriate to estimate APPI as dependent variable (Cameron and Trivedi, 2009; Wooldridge, 2012). For the regional innovation variables, new product sales of a region (RENPS) is estimated by using the OLS model as the values are in monetary form. OLS model is chosen because RENPS follows the normal distribution and OLS model is appropriate to estimate RENPS as dependent variable (Cameron and Trivedi, 2009; Wooldridge, 2012). The number of patents granted of a region (REPG), invention (INV), the utility model (UTM) and external design (EXD) are estimated by using negative binomial models[18]. I use robust errors for heteroscedasticity issue.

[17] This is because all three variables are ordered variables, with a higher ordered value meaning higher performance in innovation.

[18] Given the non-negative and discrete nature, Patent follows Poisson distribution. However, because a large number of data take zero value, to allow for 'overdispersion' into the data, the negative binomial model is used. This produces improved efficiency in estimations.

Table 7 Explanation of Variables

Dependent Variables (Firms' Innovation)	PNP	Probability of Developing New Products	FDI Variable	FDI	Foreign Direct Investment
	NPS	Ratio of New Product Sales to Total Sales	Regional Institution Variables	GOA	Regional Government Assistance
	NPdI	Whether Firms Engaged in Product Innovation		LAW	Regional Legal Institutions
	NPcI	Whether Firms Undertook Process Innovation		EDU	Regional Educational Institutions
	APPI	Application of Process Innovation in Production		FMR	Regional Financial Institutions
Dependent Variables (Regional Innovation)	RENPS	Regional New Product Sales		TAX	Regional Taxation Institutions
	REPG	Regional Patents Granted	Control Variables	RDE	R&D Expenditure
	INV	Regional Inventions		RDP	R&D Personnel
	UTM	Regional Utility Model		EXP	Exports
	EXD	Regional External Designs		COM	Competition

Table 8 Sample Statistics and Correlation Analysis

Variable	Mean	s.d.	11.	12.	13.	14.	15.	16.	17.	18.	19.
1.PNP	0.453	0.498									
2.NPS	24.389	18.82									
3.NPdI	2.379	1.469									
4.NPcI	1.621	1.191									
5.APPI	20.506	17.882									
6.RENPS	27.234	0.811									
7.REPG	10.996	1.009									
8.INV	8.719	0.839									
9.UTM	10.258	0.7441									
10.EXD	9.862	1.517									
11.FDI	23.9	0.925									
12.GOA	15.03	10.479	0.010								
13.LAW	31.99	20.579	0.069	-0.403							
14.EDU	124.1	18.955	-0.064	-0.359	0.175						
15.FMR	11.2	0.824	0.044	-0.655	0.647	-0.014					
16.TAX	204.5	10.215	0.034	0.032	-0.147	-0.693	0.067				
17.RDP	100.1	484.9	0.081	0.059	-0.117	0.003	-0.097	0.017			
18.RDE	5.121	8.735	0.089	-0.051	0.135	0.101	0.136	-0.064	-0.261		

19.EXP	4.963	7.572	-0.017	-0.104	0.147	0.019	0.160	0.061	0.278	-0.024	
20.COM	1.72	1.419	0.035	0.037	0.599	0.156	0.468	-0.235	-0.085	0.198	0.180

For all OLS models, I checked multicollinearity by using variance inflation factors (VIF). VIF scores are lower than the normally accepted threshold level of 10. I also checked multicollinearity of all models using Spearman correlation coefficients. As reflected in table 8, no pair of independent variables is highly correlated.

4.4 Results

Table 9 presents the estimation results that include FDI spillover effects (FDI), regional institution variables (GOA/LAW/EDU/FMR/TAX) and control variables (RDP/RDE/EXP/COM).

Table 9 Role of FDI and Regional Institutions in Innovation of Firms

	Logit Model	OLS Model	Ordered Logistic Model	Ordered Logistic Model	OLS Model
	PNP	NPS	NPdI	NPcI	APPI
FDI	0.189	0.838	0.245	0.415	0.886
	[1.054]	[1.026]	[0.549]	[0.428]	[0.844]
GOA	0.494***	0.138	0.178	0.450***	-0.049
	[0.191]	[0.238]	[0.128]	[0.150]	[0.230]
LAW	0.418	-1.745	-0.156	-0.462	0.220
	[0.380]	[1.530]	[0.407]	[0.465]	[1.320]
EDU	0.334***	0.039	0.141**	0.427***	-0.188
	[0.106]	[0.166]	[0.067]	[0.095]	[0.149]
FMR	2.934**	5.792**	1.496*	4.045***	3.663*
	[1.282]	[2.686]	[0.881]	[1.061]	[2.080]
TAX	0.525***	0.213	0.210**	0.634***	0.068
	[0.155]	[0.237]	[0.101]	[0.147]	[0.216]
RDP	0.000	-0.002**	0.000	0.001	-0.000
	[0.000]	[0.001]	[0.000]	[0.001]	[0.001]
RDE	0.021	0.528***	0.023	0.007	0.357***
	[0.021]	[0.101]	[0.014]	[0.008]	[0.089]
EXP	-0.004	-0.079	0.028**	0.024*	0.020
	[0.015]	[0.120]	[0.013]	[0.013]	[0.102]
COM	-3.458***	-1.455	-1.030	-2.721***	-1.637
	[1.168]	[1.306]	[0.725]	[0.887]	[1.297]
N	462	390	532	532	461
R^2	0.161	0.112	0.072	0.106	0.094

City and industry dummies are included in the estimation. Robust standard errors are in parentheses. 'N' is the number of observations. ***, ** and * indicate that the coefficient is significantly different from zero at the 1%, 5% and 10% levels respectively.

In terms of the impact of FDI on innovation, it is clear that FDI generates no direct spillover effects on the innovation of Chinese manufacturing firms.

Such a result is basically consistent with the finding in chapter 3, because both chapters show that FDI generates no spillover effects on new products (PNP & NPS), new product innovation (NPdI) and new process innovation (NPcI). In chapter 3, FDI does generate negative spillover effects on patents granted; however, as the patent data is unavailable in this chapter, it is not possible to investigate the role of FDI in the patents of Chinese firms.

For regional institution variables, legal institutions (LAW) are found to generate an insignificant effect on firms' innovation, which is basically consistent with the finding in chapter 3. Government assistance (GOA) has a positive effect on PNP and NPcI, which means that regions with higher government assistance are more likely to have higher PNP and NPcI, being supporting the finding is chapter 3. Educational institutions (EDU) positively affect PNP, NPdI and NPcI, which means that regions with higher level of educational institutions are more likely to expect higher PNP, NPdI and NPcI. Financial institutions (FMR) have a positive effect on all innovation categories, which means that regions with higher level of financial institutions are more likely to have better innovation performance. Taxation institutions (TAX) positively affect PNP, NPdI and NPcI, which means that regions with higher level of taxation institutions are more likely to have better performance in PNP, NPdI and NPcI.

Table 9 also clearly shows the importance of control variables in determining a firm's innovation performance. R&D expenditure (RDE) positively influences NPS and APPI. R&D personnel (RDP) have a negative effect on NPS. Exports (EXP) generate a positive effect on NPdI and NPcI. Competition (COM) has a negative effect on PNP and NPcI.

Besides considering institution as a determinant of firms' innovation, as has been done in chapter 3, I have also investigated its role in regional

innovation. Table 10 presents the estimation results of the role of FDI and regional institutions in the regional innovation of China.

Table 10 Role of FDI and Regional Institutions in Innovation of Regions

	OLS Model	Negative Binomial Model	Negative Binomial Model	Negative Binomial Model	Negative Binomial Model
	RENPS	REPG	INV	UTM	EXD
FDI	-0.004	-0.000	-0.001	-0.000	0.000
	[0.012]	[0.001]	[0.001]	[0.001]	[0.002]
GOA	0.007	0.004***	0.006***	0.003***	0.007***
	[0.005]	[0.000]	[0.001]	[0.000]	[0.001]
LAW	0.216	0.049***	0.007***	0.018***	0.112***
	[0.020]	[0.001]	[0.002]	[0.002]	[0.002]
EDU	0.042***	0.005***	0.008***	0.004***	0.009***
	[0.002]	[0.000]	[0.000]	[0.000]	[0.000]
FMR	0.562***	0.073***	0.120***	0.079***	0.093***
	[0.043]	[0.003]	[0.007]	[0.003]	[0.007]
TAX	0.033***	0.005***	0.010***	0.004***	0.009***
	[0.003]	[0.000]	[0.000]	[0.000]	[0.000]
RDP	-0.000	-0.000	-0.000	-0.000	-0.000
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
RDE	0.001	0.000	0.000***	-0.000	0.000***
	[0.001]	[0.000]	[0.000]	[0.000]	[0.000]
EXP	0.002	0.000**	0.000***	0.000	0.000*
	[0.001]	[0.000]	[0.000]	[0.000]	[0.000]
COM	0.003	-0.018***	-0.001	-0.011***	-0.049***
	[0.025]	[0.002]	[0.003]	[0.002]	[0.004]
N	532	532	532	532	532
R^2	0.886	0.018	0.017	0.010	0.046

City and industry dummies are included in estimation. Robust standard errors are in parentheses. 'N' is the number of observations. ***, ** and * indicate that the coefficient is significantly different from zero at the 1%, 5% and 10% levels respectively.

FDI produces an insignificant effect on the regional innovation of China. For the regional institution variables, government support (GOA), legal institutions (LAW), educational institutions (EDU), financial institutions (FMR) and taxation institutions (TAX) produce very significant and positive effects on all the regional innovation categories, with only the exception of

the role of government support (GOA) and legal institutions (LAW) in the regional new product sales (RENPS), which is insignificant. The positive role of government support and legal institutions in the patents granted to a region confirms the finding from the chapter 3 that they play an important role in innovation. Also, confirming the finding from chapter 3, the patents granted as a type of innovation are more protected than other types of innovation in China.

Regional formal institutions tend to generate much less impact on the innovation of regions compared with their impact on the innovation of firms. One reason behind may be that regional formal institutions produce more effects on firms in certain cities rather than on the whole province. The regional formal institutions are more effective in improving innovation performance of certain groups of firms in a region than improving that of others. Despite significant relationship between regional formal institutions and regional innovations, the regional formal institutions' effects are different across cities and have different levels of impact on the innovation.

4.5 Discussions and Implications

Overall, the regional institutions in China have a significantly positive effect on both firms' innovation and regional innovation, and this finding supports the finding from the chapter 3 that the formal institutions in China promote innovation.

First of all, for firms' innovation, the finding of this chapter suggests that regional government support plays an important role in promoting the probability of developing new products and new process innovation of Chinese manufacturing firms, and this finding is consistent with the finding

from chapter 3, suggesting the importance of government support in firms' innovation. For regional innovation, it suggests that the regional government support promotes the total number of patents granted in a region and all the three types of patent granted in a region (invention, utility model and external design). The regional governments in China should therefore provide assistance, supportive policies and efficient allocation of resources to firms' innovation (Lu et al., 2008). Moreover, building links between economic agents of innovation such as firms, universities, research institutions and financial providers is also an effective way of supporting innovation in a region (Gu et al., 2009). Regional governments need to guarantee fairness in the resource allocation process and make sure the resources of innovation go to the parties that need them most. Also, offering training to firms on how to use regional R&D resources efficiently and effectively can also help to upgrade their capabilities in R&D and innovation (Zhu et al., 2012).

On the one hand, for firms' innovation, there is no significant effect of the legal institutions on firms' probability of developing new products, new product sales, types of new product innovation, types of new process innovation and the application of new process innovation in production by Chinese firms. This basically supports the finding from the chapter 3 that the legal institutions in China cannot effectively promote the above types of innovation of Chinese manufacturing firms. One possible explanation is that the regional legal protection for new product innovation and new process innovation of Chinese manufacturing firms is inefficient, discouraging firms from making such innovations. New products and new processes capture some innovations that are not patented (Liu and Buck, 2007). These unpatented innovations are exposed to the risks of being illegally imitated and violated by other firms in China. The protection of property rights is still poor in China (Athanasakou, 2007; Gassmann et al., 2012). Imitations

originating from China have experienced significant growth over the past two decades. Also, violations and theft regarding intellectual property have rapidly increased in terms of both range and volume of products affected (Gassmann et al., 2012). The serious information asymmetry (non-transparency) together with the flood of imitations in China generate risks to firms' innovation. It is indicated that the output of illegal imitations from China develops at the same speed as the legal production, contributing to over half of the world total of fake products (Gassmann et al., 2012). Such inefficiency in the regional legal institutions of China increases costs and risks associated with new product and new process innovations, discouraging Chinese firms from making such innovations. On the other hand, however, the regional legal institutions promote the patents granted. Its positive role in patents granted supports the finding from chapter 3, suggesting that the legal system in China is biased towards protecting patents over new products or new processes. There is not as much attention being paid to the new products or new processes of Chinese firms as is being paid to the patents. Overall, Chinese governments need to improve the efficiency of law enforcement and strengthen property rights protection, especially on new products and new processes, in order to limit regional illegal imitations and violations of property rights and encourage new product and new process innovations. Also, they should work closely with international organizations in order to follow the step of the development of law enforcement in developed countries and acquire experience on how to enforce the law efficiently (Qiu and Yu, 2010). This can also help local governments discover violations of law and detect problems associated with law enforcement.

Further, for firms' innovation, the regional educational institutions promote the probability of developing new products, and new product and new process innovation of Chinese firms. For regional innovation, the regional

educational institutions promote new product sales, patents granted and all the three types of patent granted in a region. The educational institutions of a region play a critical role in building firms' capabilities in absorbing new knowledge and skills and applying them in the production process (Martin and Trippl, 2013). Moreover, knowledge transfers play an important role in shaping regional innovation, and education and training bodies of a region can mediate the level of knowledge transfers, thus improving the innovation of a region (Edquist, 2006). Therefore, developing the educational institutions of a region and building links between them and local firms are important, as universities, R&D institutions and training bodies generate new knowledge and skills, and they are also carriers of new knowledge, skills and talent, contributing significantly to innovation (Gunasekara, 2006). With sound development of the regional educational institutions, the regional knowledge pool and talent pool can be built, resulting in low costs in acquiring knowledge and talent within that region; as a result, firms' costs of innovation can be reduced and opportunities of innovation can be enhanced (Gunasekara, 2006).

Moreover, for firms' innovation, the regional financial institutions are shown to be an important innovation promoting factor in all the investigated innovation categories, namely, firms' probability of developing new products, new product sales, new product innovation, new process innovation and the application of the new process to production. For regional innovation, the regional financial institutions promote new product sales, patents granted and all the three types of patent granted in a region. This finding provides support for the existing literature. Edquist (2006) suggests that the financial system of a region plays an essential role in supporting and promoting knowledge generation and transfer, which underpin regional innovation. Zhu et al. (2012) find that the difficulty in obtaining finance is one of the most significant institutional barriers in

China, which affects both costs and opportunities of innovation and matters significantly in the innovation of SMEs in China. Therefore, for Chinese regional governments, the development of the financial market in a region and offering financial support to firms can significantly improve firms' innovation performance in that region. Meanwhile, reducing the costs of financing and enabling multiple financing channels in a region can further reduce the risks and costs of firms' innovation in that region (Zhu et al., 2012). Moreover, credible financial providers should be encouraged to enter regional financial markets to provide diverse financing channels to firms, which can also make the local financial market competitive (Garnaut and Song, 2007). Regional governments should eliminate unfairness in the credit/loan resource allocation process and promote high efficiency in the regional financial market (Garnaut and Song, 2007).

Last, for firms' innovation, the results suggest a significant and positive effect of the regional taxation institutions on firms' probability of developing new products and new product and new process innovation. For regional innovation, the regional taxation institutions promote new product sales, patents granted and all the three types of patent granted in a region. This finding lends empirical support to theoretical arguments made in the existing literature. Zhu et al. (2012) suggest that the tax burden is one of the most significant institutional barriers in China, which affects both costs and opportunities of innovation and matters significantly in the innovation activities of SMEs. Therefore, for Chinese regional governments, as taxation practices differ across provinces in China, reforming taxation systems within provinces, reducing the tax burden upon firms and seeking trade-offs between the interests of firms and those of the regional governments are important. A lower tax burden in a region will enable regional firms to have more funds for innovation and have more incentives to innovate, thus reducing the costs and increasing the opportunities of

innovation (Zhu et al., 2012). This is supported by the finding that a lower tax burden in a region does contribute to both firms' innovation and regional innovation.

Overall, FDI produces insignificant spillover effects on both firms' innovation and regional innovation. This may result from firms' focus on the integration between adaptive production and innovation, as the negative and positive FDI spillover effects offset each other, therefore the net effects appear to be statistically insignificant. It may be also because the improvements in absorptive and innovation capabilities of Chinese firms offset the negative competition effects from FDI, in which case, the net impact tends to be insignificant as well. Moreover, the study suggests that FDI plays an insignificant role in the regional patents granted, while, in chapter 3, it is shown that FDI plays a significant and negative role in the patents granted to Chinese manufacturing firms. My explanation is that foreign-invested firms crowd out indigenous Chinese firms and produce a negative impact on patenting by the indigenous firms, as has been discussed in chapter 3. At the regional level, as foreign firms set up many R&D laboratories and generate a large number of patents locally, contributing to the regional patents granted, the negative 'crowding-out' effect brought by foreign-invested firms and the positive contribution made by foreign R&D laboratories in one region offset each other; as a result, the net effect tends to be insignificant.

4.6 Conclusion

Different regions tend to have different regional formal institutions (Asheim et al., 2011), and this is especially true for a country like China with more than 30 provinces. Existing studies on formal institutions tend to focus on

the national institutions (Edquist, 2006; Lu et al., 2008), neglecting the diversities across regions within a single country. Moreover, as the engine of economic development, the determinants of innovation still require further exploration. However, the role of regional institutions in innovation is under- explored (Liu et al., 2014). In order to address the research gap and enrich the literature on regional institutions, this chapter is one of the first attempts to examine five main aspects of regional formal institutions in China, including government support, legal institutions, financial institutions, educational institutions and taxation institutions. Building on an institution-based view and the literature on regional institutions and FDI spillover effects, this chapter investigates the role of regional formal institutions and FDI in the innovation of Chinese firms and Chinese regions.

The findings indicate that FDI produces an insignificant effect on both the innovation of Chinese firms and that of Chinese regions. Overall, financial institutions, taxation institutions, educational institutions and government support promote the innovation of Chinese firms, while the legal institutions have no effect on firms' innovation. In terms of their impact on the regional innovation, all five regional institution components produce a significant and positive impact.

The empirical results have significant managerial and policy implications. The regional government support plays an important role in promoting the probability of developing new products and new process innovation of Chinese manufacturing firms. The regional government support also promotes the total number of patents granted in a region and all the three types of patent granted in a region. The regional governments in China should therefore provide assistance, supportive policies and efficient allocation of resources to firms' innovation (Lu et al., 2008). Regional governments need to guarantee fairness in the resource allocation process

and make sure the resources of innovation go to the parties that need them most.

The regional legal protection for new product innovation and new process innovation of Chinese manufacturing firms is inefficient, discouraging firms from making such innovations. Such inefficiency in the regional legal institutions of China increases costs and risks associated with new product and new process innovations, discouraging Chinese firms from making such innovations. On the other hand, however, the regional legal institutions promote the patents granted, suggesting that the legal system in China is biased towards protecting patents over new products or new processes. Overall, Chinese governments need to improve the efficiency of law enforcement and strengthen property rights protection, especially for new products and new processes, in order to limit regional illegal imitations and violations of property rights and encourage new product and new process innovations.

The regional educational institutions promote the probability of developing new products and new product and new process innovation of Chinese firms. For regional innovation, the regional educational institutions promote new product sales, patents granted and all the three types of patent granted in a region. Therefore, developing the educational institutions of a region and building links between it and local firms are important, as universities, R&D institutions and training bodies generate new knowledge and skills, and they are also carriers of new knowledge, skills and talent, contributing significantly to innovation (Gunasekara, 2006).

The regional financial institutions and taxation institutions are shown to be important innovation promoting factors for firms and regions. Therefore, for Chinese regional governments, the development of the financial market in a

region and offering financial support to firms can significantly improve firms' innovation performance in that region. Meanwhile, reducing the costs of financing and enabling multiple financing channels in a region can further reduce the risks and costs of firms' innovation in that region (Zhu et al., 2012). Moreover, for Chinese regional governments, as taxation practices differ across provinces in China, reforming taxation systems within provinces, reducing the tax burden upon firms and seeking trade-offs between the interests of firms and those of the regional governments are important.

Chapter 5: Linking R&D Strategy, NIS and FDI to Firm Performance

5.1 Introduction

R&D is important for attaining competitive advantages and improving performance (Kim and Nelson, 2000). There are three different R&D strategies: duplicate imitation, creative imitation and original innovation. With a duplicate imitation strategy, firms purely clone products from their competitors. With a creative imitation strategy, firms add new features and performance to their own products on the basis of competitors' original products. With an original innovation strategy, firms introduce new products or services into the market based on their own R&D and technologies (Kim, 2004). The existing research tends to focus mostly on innovation and firm performance (Garcia and Calantone, 2002). However, imitation is also a valid strategy, especially for firms in emerging countries, as it may help firms achieve competitive advantages with lower costs and fewer resources than an innovation strategy. Imitation should be regarded as a spectrum which varies in magnitude, and researchers need to consider the level of imitativeness versus the level of creativeness when investigating imitation (Luo et al., 2011). The existing empirical studies make little distinction between whether the imitation is duplicate or creative, with the exception of Lee and Zhou (2012) who empirically test the role of duplicate and creative imitation strategies in promoting financial and market performance of Chinese firms. The investigation into different types of imitation activities is a must-do step for better understanding of R&D strategies and their impact on performance. This represents an important research gap that is to be addressed in this study in the context of China. China presents a rich context

because imitation is prevalent. Due to the weakness in its intellectual property rights (IPR) protection system, growing competition and a large amount of inward FDI, many Chinese firms are taking an active role in imitating the products of foreign-invested firms (Zhou, 2006). Meanwhile, many Chinese firms have evolved from duplicate imitators to creative imitators, or from creative imitators to original innovators and they are contributing to the overall innovation of China (Luo et al., 2011). This chapter focuses on the role of duplicate imitation, creative imitation and original innovation strategies in the performance of Chinese manufacturing firms.

Related to R&D and firm performance, China has experienced tremendous changes in its national innovation systems (NIS) (Hoskisson et al., 2000; Zhou et al., 2005). Chinese governmental institutions, especially the Ministry of Science and Technology (MOST), are making efforts to promote R&D and innovation and have made various plans such as the Science and Technology Development Plan 2006-2020 (STDP), aiming to transform China into an innovative country (Boeing, 2010; Zhong and Yang, 2007).

FDI is the carrier of financial capital, managerial skills, advanced knowledge and technologies (Dunning and Lundan, 2008). FDI produces an impact on firm performance through various channels, including access to finance, the introduction and demonstration of new skills and knowledge, the enhancement of competition and the training of staff (Cheung and Lin, 2004; Chen and Mohnen, 2009; Lin and Lin, 2010). Today, China has become one of the largest recipients of FDI and it is affecting the performance of Chinese firms significantly (though not always positively as the previous results suggest). With foreign entry and foreign technologies and know-how, it is possible for indigenous firms to acquire and assimilate foreign technologies and make use of FDI spillover effects in order to

improve firm performance (Zhou, 2006). With an imitation strategy, indigenous firms imitate foreign products and make changes to them to improve the market performance. With an original innovation strategy, indigenous firms learn from foreign know-how and experience, and form partnerships with foreign firms in order to enhance their competitiveness and improve firm performance.

The extent of FDI spillovers can be moderated by both R&D strategies and NIS. First of all, different R&D strategies are associated with different levels of incentive and absorptive capacity of making use of foreign technologies and spillover effects (Kim and Nelson, 2000). The diverse incentives and absorptive capacities associated with different R&D strategies may affect firms' decisions on how much they are supposed to rely on foreign technologies and the amount of spillover effects that have been actually used (Cohen and Levinthal, 1989, 1990; Kerin et al., 1992; Saggi, 2002; Zhou, 2006). In addition, NIS affects the extent of FDI spillover effects. The level of protection of property rights, the level of access to market and technological information and the level of interactions and networking between organizations may all affect the amount of FDI spillover effects that firms acquire (Meyer et al., 2009). Within a well-functioning NIS, the costs and risks of acquiring FDI spillovers are low because firms are capable of countering risks and reducing costs of operation. Also, with the strong legal protection within a good NIS, foreign firms are willing to set up R&D facilities and conduct R&D locally, which enlarges the potential pool for FDI spillovers. The extent of FDI spillover effects acquired by indigenous firms may be promoted.

When looking at the existing literature, I failed to find empirical studies which investigate the role of NIS or R&D strategy in the performance of Chinese firms, and how they may affect the FDI spillover effects on Chinese

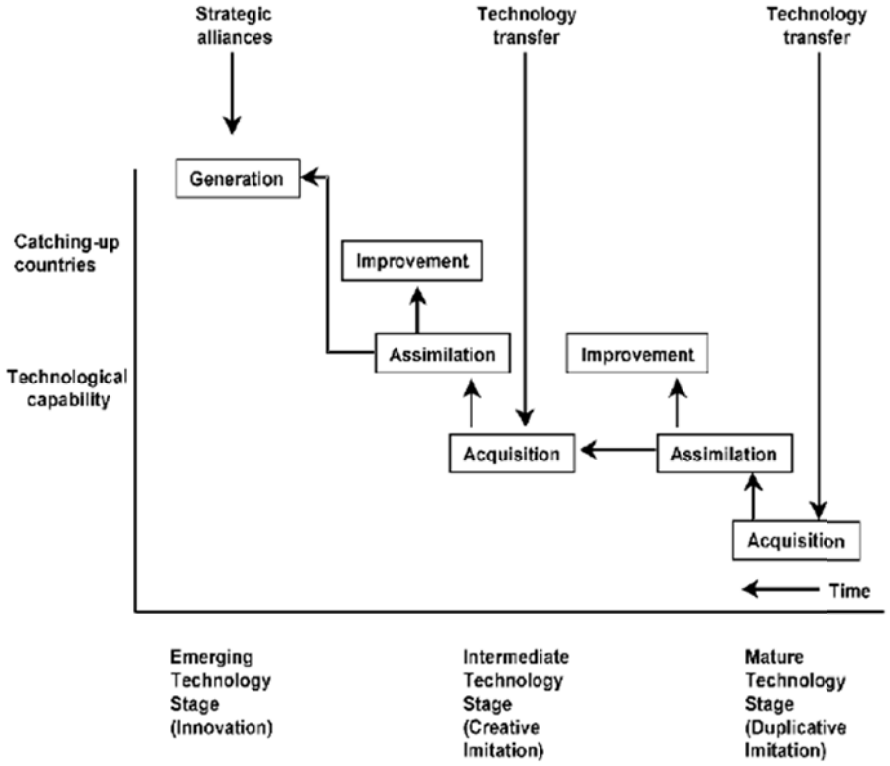
firms. In order to address the above research gap, this chapter looks at the following research questions: what is the role of R&D strategy, national innovation system and FDI in the performance of China's manufacturing firms, and what is the role of R&D strategy and national innovation system in FDI spillover effects? I propose that the performance of Chinese manufacturing firms is directly affected by FDI, R&D strategy and NIS. R&D strategy and NIS also moderate FDI spillover effects. Below, section 5.2 provides definitions on R&D strategies and NIS. Section 5.3 reviews the existing literature. Section 5.4 discusses data and methodology, which is followed by the presentation of empirical results in section 5.5 and the discussions in section 5.6. Finally, section 5.7 concludes the chapter.

5.2 R&D Strategies and NIS

5.2.1 R&D Strategies

Firms may take one of the three R&D strategies: duplicate imitation, creative imitation or original innovation (Kim and Nelson, 2000). The relationships between R&D strategies are clearly demonstrated in figure 14. It suggests a shift in R&D strategy from duplicative imitation to creative imitation, and then to innovation. This figure is useful in analysing the process of technology spillovers and the progression of firms in adopting different R&D strategies.

Figure 13: Technological Trajectory Framework



Source: Kim (2004)

It is indicated in figure 13 that, at the early stage of industrialization, firms in developing countries acquire mature technologies from advanced economies. Lacking capabilities for R&D of an original nature, these firms benefit from technology spillovers associated with foreign products. Production during this stage is mainly about the assembly operations of foreign inputs to produce undifferentiated and standard products. The acquisition of technologies by indigenous firms can lead to diffusion within the industry and the country. As competitive pressure increases, indigenous firms make efforts to assimilate more foreign technologies and produce slightly differentiated products. The assimilation of foreign technologies, the absorption of technology spillovers, the accumulation of experience and knowledge base and the enhancement in R&D capability lead to progressive improvements of mature technologies. The technological focus at this stage is duplicate imitation such as knockoffs and clones (Kim and Nelson, 2000).

The duplicate imitation is normally done through mechanisms such as reverse engineering, technical licensing agreements and technical assistance associated with OEM manufacturing (Kim and Nelson, 2000).

In the face of increasing competition, and on the basis of enhanced R&D capability, firms that have successfully acquired, assimilated and even improved mature technologies from foreign firms, may rerun the process but with intermediate knowledge. Creative imitators assimilate foreign technologies with intermediate knowledge and enhanced R&D capability to develop the products of their own. The technological focus at this stage is creative imitation, producing facsimile products but with new performance and improved features (Kim and Nelson, 2000). Creative imitation may take the forms of creative adaptations, design copies, technological leapfrogging or adaptation to other industries. Its objective is to occupy the market or become the first mover in a specific market segment with low risks and costs and improved performance of products (Kim and Nelson, 2000). Creative imitation focuses on the market and is driven by the market. A creative imitation strategy enables firms to introduce products with new features and performance derived but differentiated from those introduced by pioneers (Lee and Zhou, 2012). Between duplicative imitation and creative imitation, duplicate imitators make no modifications or only slight modifications to the original products and reposition them without giving new features and characteristics to the products, but creative imitators exploit the innovator's efforts through developing their own products based on existing products and giving them new features and characteristics (Kim and Nelson, 2000).

When a firm has abundant technological capability and knowledge base, it can develop new technologies and original products of its own. Original innovation with emerging technologies is the focus at this stage and it is

about the generation of new knowledge and emerging technologies rather than the acquisition and assimilation of foreign technologies. Original innovation is associated with pioneering activities, primarily embedded in a firm's internal competencies to develop and introduce new products to the current market for the first time (Kim and Nelson, 2000).

5.2.2 NIS

NIS refers to an evolving, open and complex system which encompasses relationships within and between organizations and socio-economic structures (Lundvall, 2007). It determines the direction and rate of competence-building and innovation emanating from the processes of experience-based and science-based learning (Lundvall et al., 2009). One key component of NIS is firms' organization of R&D activities and interaction with other firms and knowledge infrastructure in R&D activities, with the purpose of facilitating learning, sharing information and promoting R&D. This is embedded in a wider national socio-economic setting comprising financial markets, education systems, welfare regimes and intellectual property rights (Lundvall, 2007). In NIS, firms may communicate and link up with knowledge infrastructure. The access to information is an important medium during the process (North, 1993). Firms' activities are promoted or constrained by NIS and their performance is affected by NIS (Edquist, 2006). A strong NIS promotes interactions between socio-economic agents and facilitates information and knowledge sharing. Also, it protects the interests and returns from firms' R&D and reduces costs, risks and uncertainties associated with R&D through strong law enforcement. With reduced costs and risks and enhanced information and knowledge, firms' performance is likely to experience improvement.

5.3. Literature Review

5.3.1 The Role of New Product Development in Firm Performance

The prior literature has revealed that new product development is one of the keys to the success of firms in the new global economy and it can improve firm performance significantly (Clark and Wheelwright, 1992; Clark and Fujimoto, 1991; Brown and Eisenhardt, 1995; Fiol, 1996). This is due to the fact that a new product is associated with newness, improved quality and features and uniqueness and reliability, reflecting a firm's capability to meet consumers' needs and incorporate its core technological competence into product development and production (Cooper 1992; Griffin and Hauser, 1996).

Firms with new product development outperform those without (Cooper, 1983; Li and Calantone, 1998). First of all, new product development is associated with several benefits including improved quality, greater intellectual capital, enhanced brand value and improved market share (Glynn, 1996; Kessler and Chakrabarti, 1996). Also, new product development allows a firm to combine the existing core technologies with the introduction of new components. It represents one of the core competences of a firm which enables it to improve quality of products and market performance (Garud and Kumaraswamy, 1995; Nobeoka and Cusumano, 1997). This can help a firm get ahead of its competitors and allow it to respond rapidly and effectively to changes in customer requirements and technological advances, contributing to firms' market performance.

In addition, the development of competitive new products is beneficial to a firm's performance in sales because it is associated with 'product

differentiation' and 'economy of scope' (Cusumano, 1991; Markides and Williamson, 1994). Firms that have a higher rate of new product introduction expect more sales than their rivals. This is due to the fact that frequent new product introduction enables a firm to broaden the production line and replace existing products rapidly. The broadened production line makes it possible for a firm to meet and cultivate consumers' needs effectively through positioning each market niche and covering a broad range of market segments, resulting in an improved firm performance in the marketplace (Nobeoka and Cusumano, 1997).

Further, new products with superior features and enhanced functions are attractive for consumers when they believe that the benefits associated with new features outweigh the costs. This can help firms cultivate consumer preference, tastes and loyalty (Li and Calantone, 1998). As a result, a firm's performance in the product market such as sales, profits, market share and return on investment can be improved. Datar et al. (1997) suggest that time-based product development has an important impact on the market share of fast-cycle industries. The fast new product development and introduction can give firms lead-time advantage. A firm that first introduces a new product to the market can achieve sustainable market share and surpass its rivals in the marketplace (Kalyanaram and Urban, 1992; Smith and Reinertsen, 1991).

5.3.2 Duplicate Imitation Strategy and Firm Performance

A duplicate imitation strategy may improve firm performance. The costs of duplicate imitation are normally low (Ofek and Turut, 2008). This is due to the fact that existing products have already provided sufficient information on product development (Schnaars, 1994). Moreover, a duplicate imitator does not have to make many modifications to existing products, therefore it

does not require much investment in R&D. As a result, the above advantages enable a duplicate imitator to introduce duplicately-imitated products with similar functions but at lower prices. The market performance of a duplicate imitator, such as market share and total sales, may be improved after a period of time. Also, no one can predict the future precisely, and we do not know whether investment in R&D will be well rewarded (technological risks) or whether new products will have a good market response (market risks). By employing a 'wait and observe' approach, a duplicate imitator may see what happens next and accumulate experience (Gary et al., 2006). In such a way, some risks and uncertainties may be avoided because a duplicate imitator can plan carefully, based on observations, before engaging in imitating and going to the target market. Therefore, a duplicate imitator may enjoy a high possibility of success.

On the other hand, a duplicate imitation strategy may be bad for firm performance for at least three reasons. First of all, a duplicate imitator may lose chances to differentiate its products (Gary et al., 2006). This is due to the fact that in heavily focusing on duplicately-imitating products from others, a duplicate imitator may ignore or miss other market opportunities which are largely unexploited. Such market opportunities may help a firm with product differentiation and to win consumers. Rather than trying to exploit these unexploited market opportunities and differentiate products, a duplicate imitator may engage in fighting for an increasingly small market share and low profits generated from one product (Lee and Zhou, 2012; Shankar et al., 1998). As a result, a firm's performance in market share, total sales and profits may be harmed by a duplicate imitation strategy. In addition, a duplicate imitator may suffer from profit-eroding competition on prices (Mazzucato, 2002). This is due to the fact that after flooding into the same lucrative positions in a market, firms inevitably apply similar firm strategies and direct rivalry is then formed. The possible consequences are

direct price competition and an increasingly worsened performance in profits. Such direct rivalry will produce zero-sum competition eventually, and the ascending pressure on costs will hinder firms from engaging in other businesses (Mazzucato, 2002). As a result, a firm's performance in profits may be harmed by a duplicate imitation strategy. Further, a duplicate imitation strategy may result in ineffectiveness in marketing because duplicate imitators cannot properly understand the features of those products that they imitate consequently, such ineffectiveness in marketing may harm market performance of firms and bring low profits (Lee and Zhou, 2012).

There are two empirical studies on the impact of a duplicate imitation strategy on firm performanc; both of them focus on China and reach similar conclusions. Shankar et al. (1998), basing their research on the archival data on 13 brands in China's pharmaceutical industry, suggest that a duplicate imitator confronts a small market share, low profits and ineffectiveness in marketing. As a result, a duplicate imitation strategy generates a negative impact on market performance of firms. Lee and Zhou (2012), using data on 192 Chinese firms, suggest that a duplicate imitation strategy shows disadvantages in improving the financial performance of firms. Thus, both empirical studies observe a negative impact of a duplicate imitation strategy on firm performance in the market and finance.

5.3.3 Creative Imitation Strategy and Firm Performance

A creative imitation strategy may improve firm performance in a number of ways. First of all, creatively imitated products, with added values and features to the original products of rivals, are likely to attract consumers because such products can deliver extra values with reasonable prices to consumers (Zhou and Nakamoto, 2007). Also, a creative imitator can even

charge premium prices derived from the added values and functions of the products (Lee and Zhou, 2012; Shankar et al., 1998). As a result, a large amount of market share, total sales and profitability can be achieved. A creative imitator observes the performance of pioneers' new products in the market and market reactions to those products. Based on such observations and accumulated experience, a creative imitator adds value and new features to the original products and then develops products of its own. Therefore, with enhanced features and functions, a creatively-imitated product may better reflect and address customers' needs, which in turn makes this product preferable to consumers (Zhou and Nakamoto, 2007). In addition, the potential flaws and deficiencies of new products from pioneers will be exposed once they enter the market, and then a creative imitator may observe and perfect the products by correcting these flaws and deficiencies (Kim and Nelson, 2000). During the above process, a creative imitator can accumulate experience in R&D and form a knowledge base. In such a way, future costs of R&D by a creative imitator can be reduced (Brambilla et al., 2009). With an enhanced R&D capability and knowledge base, a creative imitator's performance in new product development can be improved.

Despite several advantages, a creative imitation strategy has some drawbacks. First of all, a creative imitation strategy requires investment in building up a strong R&D capability and production conditions in order to carry out a creative imitation strategy effectively (Valdani and Arbore, 2007). Such investments are risky and the returns are not guaranteed, because the new features and performance given by a creative imitator to its modified products may not be accepted and favored by consumers. Also, the investments in developing a creative imitation capability may restrict a firm's development in other domains, which may produce a negative effect on firm performance (Gary et al., 2006). In addition, a creative imitator has to compete with both duplicate imitators and the original innovator for the

targeted product market. In this case, a creative imitator may suffer from profit-eroding competition on prices. The possible consequences are direct price competition and an increasingly worsened performance in profits. The ascending pressure on costs will hinder a creative imitator from engaging in other businesses (Mazzucato, 2002). As a result, its performance in profits may be harmed by a creative imitation strategy.

Using the archival data in Chinese pharmaceutical industry, Shankar et al. (1998) indicate that a creative imitator can enjoy good firm performance by taking advantage of a pioneer's diffusion as a creative imitator enjoys a large market share, high profits and high effectiveness in marketing performance. Based on data on Chinese firms, Lee and Zhou (2012) indicate that a creative imitator enjoys good financial performance in returns on assets and good market performance in market share.

5.3.4 Original Innovation Strategy and Firm Performance

An innovation strategy may have either a negative or a positive impact on firm performance. On the one hand, innovation requires investment in building up strong production conditions and a powerful R&D capability and investment in inducing consumption and cultivating preferences of consumers. Consumers need to be informed of features and functions of the new product when it appears in a market for the first time (Valdani and Arbore, 2007). Furthermore, developing new products is risky and the outcome cannot be predicted, because it is exploring unknown territories. It is not guaranteed that intensive R&D can lead to success in new product development and later in the market. On the other hand, an innovation strategy is the key to sustainable success (Green et al., 1995). The intensive R&D associated with an innovation strategy can help a firm achieve technological leadership. With such technological leadership, an innovator’s

performance in developing new products can be improved, which in turn helps an innovator gain competitive advantages (Carpenter and Nakamoto, 1989). From the consumers' perspective, such advantages come from the powerful brand image and switching costs. This is due to the fact that a preference structure will be produced which makes the pioneer favorable to consumers, and also makes it hard for rivals to "compete away" the large market share acquired by the pioneer (Carpenter and Nakamoto, 1989). From the strategic perspective, such advantages come from pre-empting competition, capturing market demand and achieving economy of scale (Carpenter and Nakamoto, 1989; Robinson and Fornell, 1985). Also, the pioneer position resulting from an innovation strategy can pre-empt rivals who are seeking to acquire scarce resources such as the attractive locations or space, and further strengthen the above competitive advantages (Lieberman and Montgomery, 1988).

The significant role played by an original innovation strategy in firm performance is widely recognized by prior studies (Carpenter and Nakamoto, 1989; Green et al., 1995; Kerin et al., 1992; Robinson and Fornell, 1985; Zhou, 2006). Capon et al. (1990) find that a majority of empirical studies suggest a positive impact of innovation strategy on firm performance. Szymanski et al. (1995), based on a meta-analysis of 23 empirical studies, reveal that an innovation strategy can improve market performance of firms by enlarging market share and making marketing strategies effective. Lieberman and Montgomery (1998), in their reviews of extensive prior literature, find that an innovation strategy which is robust in practice can contribute significantly to firm performance in new product development. Zhou (2006) finds that the impact of innovation strategy on new product performance is positive. Morgan and Berthon (2008), using a dataset of 160 bioscience firms, test the impact of exploitative and explorative innovation strategies on firm performance. Their findings

suggest that both forms of innovation strategies generate significantly positive effects on firm performance.

5.3.5 Imitation Versus Original Innovation in Firm Performance

Successful innovators can even outsell superior imitators, acquire large market share and high profits, and enjoy strong firm performance (Carpenter and Nakamoto, 1989; Green et al., 1995). An original innovation strategy is the key to sustainable success. With it, a firm substantially invests into R&D in order to become the first one to introduce innovative products to the market place (Green et al., 1995). An original innovation strategy can bring more benefits to a firm than an imitation strategy for several reasons. First of all, a first mover can achieve certain economic benefits such as experience, tacit knowledge and scale economies, which is hard to obtain for imitators. These benefits can help an innovator achieve sustainable growth and firm performance through reducing risks and costs in product development and production (Robinson and Fornell, 1985). In addition, with technology leadership, unlike imitators, an innovator has the potential to create markets, generate market demand, form consumer preferences, even alter the consumer behaviour and bring strong performance in the market place (Kerin et al., 1992; Zhou et al., 2005). Further, unlike an innovator who endeavors to exploit new markets and develop new products, an imitator may lose chances to differentiate its products (Gary et al., 2006). This is due to the fact that in heavily focusing on imitating products from others, an imitator may ignore or miss other market opportunities which are largely unexploited; while through mastering such market opportunities an innovator can achieve product differentiation, win consumers and improve firm performance (Gary et al., 2006). Last, an innovator enjoys more effectiveness in marketing than an imitator because an innovator has a much better understanding of the

features of their own products than any potential imitators; consequently, such effectiveness in marketing can help an innovator achieve better performance in the marketplace than an imitator (Lee and Zhou, 2012; Shankar et al., 1998).

In their review of the extensive existing literature, Lieberman and Montgomery (1998) suggest that innovation has advantages and early entry is robust in practice. They indicate that an innovation strategy can contribute more to the success of a firm than an imitation strategy. Zhou (2006) compares the effects of an imitation strategy with an innovation strategy on firm performance in new products. The empirical results from this study suggest that, compared with an imitation strategy, an innovation strategy helps to develop better new products.

5.3.6 NIS and Firm Performance

NIS affects firm performance in a number of ways. First of all, the efficiency and effectiveness of firms' business activities are affected by NIS (Lu et al., 2008). A strong NIS promotes interactions between socio-economic agents and facilitates information and knowledge sharing. Also, it protects the interests and returns from firms' R&D and reduces costs, risks and uncertainties associated with R&D through strong law enforcement. A strong NIS also provides adequate and high-quality services to firms and help firms with their R&D, production and introduction of new products. With reduced costs and risks, enhanced information and knowledge as well as high-quality services, firms' performance in both product development and product market may experience improvement. To the contrary, a weak NIS raises costs and reduces efficiency and effectiveness of business activities through blocking information and knowledge sharing and producing risks for firms' R&D. With a poor NIS,

firms cannot fully appropriate the income from their R&D; rather, poor law enforcement is normally associated with violations of intellectual property rights and counterfeits, which endanger firms' innovation and discourage R&D. Such poor law enforcement produces high costs, risks and uncertainties, which restrict the further improvement on firm performance in product development and product introduction. Also, with a weak NIS, firms may not have access to the high-quality services provided by the governments, which may further restrict firms' capability of countering risks and uncertainties, resulting in poor performance of firms in both product development and product market.

In addition, NIS affects interactions among economic agents within or across industries, between universities and industries, between suppliers and consumers and between foreign and indigenous firms, and it influences the development of the R&D infrastructure (Edquist, 2006). A strong NIS stimulates competition, improves communication, builds networks between economic agents and forms a knowledge base (Dunning and Lundan, 2008). A strong NIS directs businesses towards more economically productive activities and raises efficiency. Thus, a firm's performance in product development and the product market can expect improvements. To the contrary, within a weak NIS, communication and interactions between organizations are poor. As a result, information, knowledge, experience and services cannot be effectively shared and delivered. Firms have to counter risks and overcome difficulties in product development and market products mostly on their own, and this generates high uncertainties and costs and may negatively affect firms' performance in R&D and product introduction. Affected by poor communication, high costs and high uncertainties, a poor NIS constrains the effective allocation of resources towards firms' R&D and raises inefficiency in firms' business activities.

5.3.7 FDI Spillovers and Firm Performance

FDI affects the performance of indigenous firms through reducing the bottlenecks in supply chains, introducing new practical knowledge and skills, demonstrating advanced technologies and training employees who may later be employed by indigenous firms (Lin and Lin, 2010). It is possible for indigenous firms to learn some of the knowledge and skills through learning-by-watching, learning-by-doing and reverse engineering and enhance their performance in quality of products and market share as a result (Cheung and Lin, 2004). FDI injects much-needed funds into indigenous firms for their expansion (Girma et al., 2009). FDI can also break down monopolies and encourage competition (Blomström and Kokko, 1998).

The competition pressure associated with FDI inflows may affect the performance of indigenous firms in two ways. On the one hand, FDI inflows push indigenous firms to enhance technological capacity and upgrade organizational practices in order to better compete with MNEs. As a result, indigenous firms' performance in the quality of products and market share can be improved (Lin and Lin, 2010). On the other hand, FDI may decrease the level of profits in indigenous firms and may crowd out them in both product and resource markets (Girma et al., 2008). MNEs and indigenous firms compete with each other for skilled labour, capital and land, which pushes up the operating and production costs of indigenous firms and pushes down their profits and resources available for production. Also, MNEs normally provide competitive offers to quality staff in host countries; as a result, the wages and costs of production may be pushed up and profits of indigenous firms may be pushed down. Indigenous firms may also fail when providing final goods and services because MNEs have strength in the quality of products and brand names (Dunning and Lundan, 2008). As a

result, the competitive pressure produced by inward FDI may eventually be harmful to the performance of local firms in sales, profits and market share.

5.3.8 Moderation Effects of R&D Strategy and NIS on FDI Spillovers

The level of impact of FDI on firm performance can be moderated by both R&D strategies and NIS. First of all, different R&D strategies are associated with different levels of incentive and absorptive capacity of making use of foreign technologies and spillover effects. The diverse incentives and absorptive capacities associated with different R&D strategies may affect firms' decisions on how much they are supposed to rely on foreign technologies and the amount of spillover effects that have been actually used (Cohen and Levinthal, 1989, 1990; Kerin et al., 1992; Saggi, 2002; Zhou, 2006). More specifically, firms that use a duplicate-imitation strategy have a strong incentive but weak absorptive capacity to make use of FDI spillovers because they rely heavily on foreign technologies in market competition and improvement of firm performance (Brambilla et al., 2009). On the other hand, firms that use an original innovation strategy have strong absorptive capacity but a weak incentive to make use of FDI spillovers, because they build firm performance on their own strong R&D capability and technologies rather than relying heavily on foreign technologies. Firms that use a creative imitation strategy rely on both foreign technologies and their own R&D, resulting in different levels of inventive and absorptive capacity from both duplicate imitators and original innovators (Kim and Nelson, 2000). Therefore, the adoption of different R&D strategies is likely to affect the extent of FDI spillovers that firms acquire.

In addition, NIS affects the extent of FDI spillover effects. The level of protection of property rights, the level of access to market and technological information and the level of interactions and networking between

organizations may all affect the amount of FDI spillover effects that indigenous firms acquire (Meyer et al., 2009). Within a well-functioning NIS, the costs and risks of acquiring FDI spillovers are low because firms are capable of countering risks and reducing the costs of operation through acquiring information, being protected by law and communicating with other social-economic agents (Gachino, 2006). Indigenous firms' capability and incentive to make use of FDI spillover effects can be supported and enhanced. Also, foreign firms may be willing to transfer technologies and know-how to host countries within a strong NIS framework and they may undertake a large amount of R&D activities locally, extending the potential pool of FDI spillovers. As a result, the extent of FDI spillover effects acquired by indigenous firms can be promoted. To the contrary, within a poor NIS, indigenous firms are incapable of making good use of FDI spillover effects because the channels for acquiring information, the communication between organizations and the absorptive capacity are weak. Also, the amount of technological transfers by foreign firms to host countries may be restricted and the amount of foreign R&D may be reduced as well because of the risks of being imitated and violated, shrinking the potential pool of FDI spillovers locally. Consequently, the extent of FDI spillover effects acquired by indigenous firms will be constrained.

5.3.9 Other Determinants of Firm Performance

First, R&D expenditure reflects firms' commitment to develop new knowledge, create improved products and services and advance new processes through applying existing technological stock and embracing technologies created by others. R&D expenditure plays a critical role in a firm's growth. A number of studies find a positive and significant relationship between R&D expenditure and firm performance in China (Fu, 2008; Girma et al., 2008; Wang and Kafouros, 2009).

In addition, the number of technological personnel (scientists and technicians) employed in indigenous firms is also found to have significant impact on firm performance in many studies (Chen, 2007; Furman and Hayes, 2004; Furman et al., 2002). Liu and Buck (2007) argue that firms with more scientists and technicians are likely to have better performance. They find that scientists and technicians employed in these firms can actively learn from foreign-invested firms. Deng (2009) suggests that the technological human resource together with expenditure on R&D activities are treated as two critical inputs of improving firm performance.

Further, export is seen as an important factor in improving firm performance (Girma et al., 2008; Girma et al., 2009; Liu and Buck, 2007; Liu and Zou, 2008; Wang and Kafouros, 2009). Exports enable firms to compete in a global context that is normally more fierce than competition in a domestic market. Through competing in an international context, firms acquire experience, information and knowledge from competition which can be employed to improve market performance. Also, through building networks with foreign partners, firms acquire quality knowledge, skills, information and experience from those partners. Firms' capability of improving profitability and returns can be enhanced.

Last, competition is recognized as one significant factor which may affect firm performance. On the one hand, a firm's performance may be improved when fierce competition presents as it acquires experience, knowledge and information from competition (Brambilla et al., 2009). On the other hand, competition may also reduce the incentives of firms to improve performance as the returns to firms in fierce competition will be much less, while, the risks and uncertainties associated will it will be much more.

5.4 Data and Methodology

5.4.1 Data

The primary source of data is *World Bank Enterprise Survey* (WBES) 2003 on Chinese firms[19,20,21]. I use *WBES 2003* for all the variables except the FDI variable. Refer to section 3.3.1 for more information regarding the *WBES 2003*. For the industry-level FDI variable, I employ the *China Statistics Yearbook on Science and Technology 2000-2002*. All variables in monetary form are deflated by using producer price indices (base year = 2000) from the *China Statistics Yearbook*. The combination of industry-level and firm-level data allows for in-depth analysis. Altogether, there are 2,400 firms in *WBES 2003* and 1,609 of them are manufacturing firms including 158 foreign-invested firms. Because this chapter focuses on the innovation of indigenous firms, the foreign-invested firms are excluded, which leaves 1,451 firms for estimation. The dataset has been checked for outliers and missing values.

5.4.2 Variable Measurement

Market performance reflects the market acceptance of products (effectiveness); it is related to the end users of products and directly reflect aspects such as quality, cost effectiveness and market competition (Bennenbroek and Harris, 1995; Ganotakis and Love, 2011; Leiponen, 2000;

[19] There are also 2002 and 2005 WBESs on Chinese enterprises. However, different questionnaire were used in those surveys which do not contain many of the variables under investigation in this chapter, e.g. property rights protection, access to information and profitability, therefore 2002 and 2005 WBESs are not used.

[20] Similarly, the new 2012 WBES does not contain many of the variables under investigation in this chapter including market share, profitability, R&D strategy (no patents), access to information, property rights protection and number of competitors, therefore 2012 WBES is not used for this chapter.

[21] This 2003 dataset has been used in previous research including Brambilla et al. (2009), Cull and Xu (2005) and Lin et al. (2010).

Weiss, 1968). I use market share, profitability and total sales to capture market performance. As the market share alone cannot reflect the price premium that consumers wish to pay and the perceived values that they can get from these products, therefore, profitability and total sales should be considered as well. Market share (MAR) is measured as the percentage of the total sales in a major market, profitability (PFT) as the ratio of the volume of total profits to total assets, and total sales (SAL) as the logarithm transformation of the volume of total sales.

The primary independent variables of interest are a firm's probability of developing new product, R&D strategy, national innovation system variables and FDI. As this research distinguishes between duplicate imitation, creative imitation and original innovation, it uses the following method to identify a firm's R&D strategy.

First, as both imitators and innovators engage in new product development to some extent (Kim and Nelson, 2000; Lee and Zhou, 2012), I investigate whether firms engage in developing new products as innovators or imitators by using a question in the survey. It asks, "Has your firms introduced new products or entered a new business line during the past three years (WNP)?" A total of 724 indigenous firms in the sample were identified to have developed new products, while the rest of the 727 firms did not introduce new products or new business lines in the three years before they were surveyed. A dummy variable is then used for the whole sample with "1" representing firms with new product development during the past three years and "0" otherwise, to investigate whether a firm being an imitator/innovator has an effect on its firm performance. Second, each of the 724 firms that have developed new products during the past three years is given a score based on their performance in three areas: patenting, R&D

expenditure and process innovation[22], to further look, among the three R&D strategies, at which one is the most effective in terms of improving firm performance. Patenting is widely recognized as an indicator of a firm's R&D activities (Lin and Chen, 2005; Schumann and Ransley, 1995; Werner and Souder, 1997). The same is true for investment in R&D (Chiesa and Masella, 1996; Schumann and Ransley, 1995; Werner and Souder, 1997). Process innovation is about a firm's status in new management techniques, new process and new quality controls development (Lin et al., 2010); therefore, it is also an integral part of a firm's R&D besides product innovation. Milling and Stumpfe (2000) suggest that there are interdependencies between the product and process innovations. The latter is essential for the generation of the former. Kraft (1990) reveals that more process innovation is connected with more product innovation, and firms can learn and upgrade the manufacturing process while making product innovation. The comprehensive measurement for R&D strategy based on a firm's performance in patenting, R&D expenditure and process innovation allows me to mitigate the deficiencies inherent in any particular measures. I use the continuous variable instead of categorical variable to identify the firm's R&D strategy because it is not possible to identify what R&D strategy a firm exactly employs in practice and it is too arbitrary to say that a firm is an imitator or innovation based on certain method of classification. In this chapter, what can be identified by using the above 2-step method is the likelihood of certain R&D strategy that a firm employs to improve firm performance.

The *WBES 2003* permits examination of the number of patents granted, R&D expenditure by firm size and the varieties of process innovation. The total score is the sum of a firm's responses to the three questions. The

[22] In WBES 2003, firms were asked for their information on "number of patents granted in China" and, "total R&D expenditure" and ""Has the firm introduced new process improvements, new management techniques or new quality controls in production?".

aggregate score is labeled as a firm's 'R&D Strategy' (RDSG). A firm with a higher RDSG is more likely to adopt an original innovation strategy, whereas, a firm with a lower RDSG is more likely to adopt a duplicate imitation strategy. The level of RDSG is consistent with the level of R&D strategy that a firm takes.

Lundvall (2007) suggests that the core of NIS is firms' organization of in-house innovation and networking with other firms and knowledge infrastructure. This core is embedded in a wider national socio-economic setting comprising elements such as property rights and welfare regimes. Moreover, access to an information service is an important medium during the process of communication and interactions between firms and knowledge infrastructure (North, 1993). Several elements can be identified from the definition of NIS by Lundvall (2007), namely, networking (interactions), financial markets, education systems, welfare regimes, intellectual property right and access to information. As I have discussed, networking, legal institutions and access to information are three most important dimensions of NIS and these three factors can capture the aspects of NIS in China, where the factor markets (labour market and financial market) are controlled by the state. Therefore, I use three main elements based on questions in WBES 2003 to measure and operationalize NIS, including networking, legal institutions (property rights) and access to information. The way that I operationalize NIS is as follows:

1. Networking (NET):

In the WBES 2003, firms were asked whether they have a contractual or long-standing relationship with local universities, research organizations or other firms between 2000 and 2002. "1" is "Yes" and "0" is "No". The answers to all the options are combined to an order variable, with a higher value means a higher level of networking (See the appendix 3 for the

original question asked which I used to produce "NET"). "Networking" is a good indicator of NIS and it is supported by existing literature. Lundvall (2007) suggests that the core of NIS is interactions between firms, and between firms and knowledge infrastructure. Love, et al. (2013) suggest that external linkages and connections produce learning effects which can help firms generate more innovation outputs from external linkages and connections. Laursen and Salter (2006) indicate that the openness and exposure to external information and knowledge play an important role in promoting the innovation performance of manufacturing firms in the UK.

2. Legal institutions (LAW):

In the WBES 2003, firms were asked the likelihood of the legal system upholding their contracts and property rights in business disputes. The variable is a percentage, with a higher value means stronger legal protection. (See the appendix 3 for the original question asked which I used to produce "LAW"). "Legal institution" is a good indicator of NIS and it is supported by existing literature. North (1990) suggests that property rights are a key to channeling resources towards productive investments. Lundvall (2007) suggests the core of a NIS is embedded in a wider national socio-economic setting comprising of elements such as property rights and welfare regimes.

3. Access to information (ATI):

In the WBES 2003, firms were asked to state, on a scale of 1 to 5, whether they are satisfied with the availability/accessibility of information on the supply of inputs/services, demand for product, export market and import sources, technical standards and product/technology development as well as laws and regulations. The answers to all the options are combined to an order variable, with a higher value means a higher level of access to information (See the appendix 3 for the original question asked which I used to produce "ATI"). "Access to information" is a good indicator of NIS and it

is supported by existing literature. North (1993) suggests that "the incomplete information and limited capacity by which to process information determines the cost of transacting, which underlies the formation of institutions and the cost of transacting rises because information is costly and asymmetrically held by parties to the exchange" (p.2).

The FDI variable is measured by the share of foreign firms' R&D expenditure in the industry's total R&D expenditure, and data is obtained from the *China Statistical Yearbook of Science and Technology 1999-2003*. One-year lagged FDI is used in the estimation to mitigate the endogeneity effect.

As the R&D strategy variable is theoretically highly correlated with control variables of R&D expenditure and R&D personnel, these two control variables are therefore removed from the regressions. Two control variables are included in the estimations. Exports (EXP) is the log transformation of values in exports. Competition (COM) is the number of competitors within the main business line in the domestic market. Meanwhile, city and industry dummies are also incorporated in the regressions. City dummies are used to control for location specific effects and industry dummies are employed to control for the variations in firm performance in different industries. Producer Price Index (PPI) is applied to deflate all the monetary variables.

This chapter investigates the impact of deciding whether to develop new products on firm performance, the impact of R&D strategies on firm performance, the impact of FDI and NIS on firm performance, and also the possible moderation effects of R&D strategies and NIS on FDI spillovers. Therefore, in order to fulfill the above research objectives, this chapter carried out the following regressions.

In order to investigate the impact of deciding whether to develop new products on firm performance, I use the question of whether to engage in new product development (WNP) in the first group of regressions. In addition, in order to further look at the impact of R&D strategies on firm performance, I include the R&D strategy (RDSG) in the second group of regressions. Within this regression group, I am also able to investigate the impact of FDI and NIS on firm performance. Further, in order to investigate the possible moderation effects of R&D strategies on FDI spillovers, the interaction term between RDSG and FDI is then included in the third group of regressions. Last, in order to investigate the possible moderation effects of NIS on FDI spillovers, interaction term between NIS indicators and FDI is then included in the fourth group of regressions.

Table 11 Explanation of Variables

Dependent Variables (Firms Performance)	MAR	Market Share	NIS Variables (components)	NET	Networking
	PFT	Profitability		LAW	Legal System
	SAL	Total Sales		ATI	Access to Information
Status in New Product Development	WNP	Whether to Develop New Products	Moderation Variables	RDSG*FDI	Interaction Between RDSG and FDI
R&D Strategy Variable	RDSG	R&D Strategy		NIS*FDI	Interaction Between NIS and FDI
FDI Variable	FDI	Foreign Direct Investment	Control Variables	EXP	Exports
NIS Variable (built into one)	NIS	National Innovation System		COM	Competition

Table 12 Sample Statistics and Correlation Analysis

Variable	Mean	s.d.	4	5	6	7	8	9	10	11	12	13	
1.MAR	0.093	0.175											
2.PFT	3.011	6.318											
3.SAL	9.861	2.185											
4.FDI	0.269	0.115											
5.WNP	0.462	0.499	0.078										
6.RDSG	3.026	3.114	0.031										
7.RDSG*FDI	0.819	0.984	0.560										
8.NET	0.652	0.886	0.013	0.348	0.291	0.194							
9.LAW	0.681	0.367	-0.005	0.099	0.051	0.037	0.039						
10.ATI	18.322	3.812	0.039	0.050	0.040	0.042	0.060	0.108					
11.NIS	0.000	0.251	0.003		0.206								
12.NIS*FDI	0.001	0.074	0.009		0.198								
13.EXP	1.921	3.940	0.047	0.061	0.203	0.205	0.089	0.019	-0.032	0.071	0.069		
14.COM	3.448	1.320	-0.065	0.013	-0.157	-0.161	-0.147	-0.049	-0.113	-0.153	-0.154		-0.074

For all regressions, OLS models are used in estimations. OLS models are chosen for all the dependent variables because MAR, PFT and SAL follow the normal distributions and OLS models are appropriate in this case (Cameron and Trivedi, 2009; Wooldridge, 2012). Multicollinearity is checked by using variance inflation factors (VIF) and Spearman correlation coefficients. VIF scores are all lower than the normally accepted threshold level of 10. As reflected in table 12, no pair of the independent variables is highly correlated except RDSG/NIS variables and their interaction terms with FDI. I therefore do not include RDSG/NIS variables when interaction variables between RDSG/NIS and FDI are used.

5.5 Results

Table 13 presents the impact of a firm's probability of developing new products on firm performance.

Table 13 Role of Whether to Develop New Product in Firm Performance

	OLS Model	OLS Model	OLS Model
	MAR	PFT	SAL
FDI	20.897**	-0.131	-0.267
	[10.131]	[0.219]	[0.592]
WNP	0.029**	0.198***	0.831***
	[1.494]	[0.030]	[0.072]
NET	-1.577*	0.054***	0.380***
	[0.838]	[0.018]	[0.049]
LAW	0.016	0.001**	0.005***
	[0.019]	[0.000]	[0.001]
ATI	0.008	0.009***	-0.009
	[0.182]	[0.004]	[0.010]
EXP	-0.329***	0.007***	0.083***
	[0.115]	[0.002]	[0.005]
COM	-3.377***	-0.016	-0.152***
	[0.523]	[0.011]	[0.027]
N	2537	3252	3285
R^2	0.116	0.114	0.352

City and industry dummies are included in the estimation. Robust standard errors are in parentheses. 'N' is the number of observations. ***, ** and * indicate that the coefficient is significantly different from zero at the 1%, 5% and 10% levels respectively.

The results suggest that WNP has a positive impact on firm performance. Compared with firms without new product development, firms that develop new products (WNP) are more likely to enjoy better firm performance in market share (MAR), profitability (PFT) and total sales (SAL). As WNP here has an association with a firm's status of being an imitator/innovator or not, the results above indicate that firms engaging new product development,

namely, taking an imitation/innovation strategy are more likely to enjoy better firm performance than those doing otherwise.

Table 14 presents the role of FDI, R&D strategy and NIS in the performance of Chinese manufacturing firms.

Table 14 Role of FDI, R&D Strategy and NIS in Firm Performance

	OLS Model	OLS Model	OLS Model
	MAR	PFT	SAL
FDI	-0.066	0.094	1.046**
	[0.048]	[0.173]	[0.481]
RDSG	0.008***	0.030***	0.117***
	[0.002]	[0.005]	[0.016]
NET	0.018***	0.040**	0.304***
	[0.004]	[0.021]	[0.053]
LAW	0.024*	0.068	0.329**
	[0.014]	[0.050]	[0.132]
ATI	0.003***	0.005	-0.019
	[0.001]	[0.005]	[0.014]
EXP	-0.001	0.004	0.141***
	[0.001]	[0.004]	[0.011]
COM	-0.040***	-0.013	-0.179***
	[0.004]	[0.014]	[0.036]
N	1525	1510	1525
R^2	0.229	0.094	0.347

City and industry dummies are included in estimation. Robust standard errors are in parentheses. 'N' is the number of observations. ***, ** and * indicate that the coefficient is significantly different from zero at the 1%, 5% and 10% levels respectively.

The results indicate RDSG positively affects firm performance in market share (MAR), profitability (PFT) and total sales (SAL). As the R&D strategy variable here is associated with the level of originality in a firm's R&D, being an original innovator, creative imitator or duplicative imitator, the above results suggest that firms taking a more original innovation strategy are likely to have better firm performance than those taking a more creative imitation strategy. Similarly, those taking a more creative imitation

strategy are likely to have better firm performance than those taking a more duplicate imitation strategy. Therefore, a more duplicate imitation strategy is the least effective in improving firm performance, while, a more original innovation strategy is the most effective.

As the national innovation system variables, networking (NET) produces significant and positive effects on market share (MAR), profitability (PFT) and total sales (SAL). Legal institutions (LAW) positively affect market share (MAR) and total sales (SAL). Access to information (ATI) produces significant and positive effects on market share (MAR). The results from table 14 suggest that FDI produces significant and positive effects on total sales (SAL) and insignificant effects on market share (MAR) and profitability (PFT).

Table 15 presents the moderation role of R&D strategy in FDI spillover effects.

Table 15 Moderation Effects of R&D Strategy on FDI spillovers

	OLS Model	OLS Model	OLS Model
	MAR	PFT	SAL
FDI	-0.144***	-0.216	-0.215
	[0.054]	[0.186]	[0.502]
RDSG*FDI	0.026***	0.104***	0.427***
	[0.008]	[0.017]	[0.067]
NET	0.019***	0.044**	0.316***
	[0.004]	[0.021]	[0.052]
LAW	0.023*	0.064	0.310**
	[0.014]	[0.050]	[0.131]
ATI	0.003***	0.005	-0.018
	[0.001]	[0.005]	[0.014]
EXP	-0.000	0.005	0.144***
	[0.001]	[0.004]	[0.011]
COM	-0.040***	-0.013	-0.178***
	[0.004]	[0.014]	[0.036]
N	1525	1510	1525
R^2	0.224	0.093	0.347

City and industry dummies are included in the estimation. Robust standard errors are in parentheses. 'N' is the number of observations. ***, ** and * indicate that the coefficient is significantly different from zero at the 1%, 5% and 10% levels respectively.

The results suggest that the R&D strategy significantly and positively moderates FDI spillovers on market share (MAR), profitability (PFT) and total sales (SAL), confirming the moderation role of the R&D strategy in FDI spillover effects.

Table 16 presents the moderation role of NIS in FDI spillover effects. Due to the high correlation between FDI and its interaction term with ATI, ATI's possible moderation effect on FDI cannot be tested. Therefore, in order to overcome this problem, factor analysis is adopted to produce a comprehensive NIS variable (NIS) based on the three NIS variables of NET,

LAW and ATI. Also, to take into account multicollinearity between a comprehensive NIS variable and its interaction term with FDI, table 16 presents results that include the interaction term but not the comprehensive NIS variable.

Table 16 Moderation Effects of NIS on FDI Spillovers

	OLS Model	OLS Model	OLS Model
	MAR	PFT	SAL
FDI	-0.070	0.094	1.066**
	[0.048]	[0.173]	[0.485]
RDSG	0.009***	0.030***	0.123***
	[0.002]	[0.005]	[0.017]
NIS*FDI	0.323***	0.490*	2.177***
	[0.060]	[0.262]	[0.648]
EXP	-0.000	0.004	0.149***
	[0.001]	[0.004]	[0.012]
COM	-0.040***	-0.014	-0.184***
	[0.004]	[0.014]	[0.036]
N	1525	1510	1525
R^2	0.231	0.093	0.333

City and industry dummies are included in the estimation. Robust standard errors are in parentheses. 'N' is the number of observations. ***, ** and * indicate that the coefficient is significantly different from zero at the 1%, 5% and 10% levels respectively.

It can be clearly seen that NIS significantly and positively moderates FDI spillovers on market share (MAR), profitability (PFT) and total sales (SAL), confirming the moderation role of NIS in FDI spillover effects.

5.6 Discussions and implications

The empirical results suggest that firms with new product development (being an imitator or innovator) are more likely to enjoy better firm performance than those doing otherwise. This finding is consistent with the existing literature that firms with new product development outperform those without (Cooper, 1983; Li and Calantone, 1998). A new product

development is associated with several benefits including lower cost, improved quality, improved market share, greater intellectual capital and enhanced brand value (Glynn, 1996; Kessler and Chakrabarti, 1996). Frequent new product introduction enables a firm to broaden its production line and replace existing products rapidly. The broadened production line makes it possible for a firm to meet and cultivate consumers' needs effectively through positioning each market niche and covering a broad range of market segments. This can help a firm get ahead of its competitors and contributes to firms' market performance such as sales, profits, market share and return on investment (Li and Calantone, 1998).

As a general strategy, firms can engage in new product development and introduction by using R&D strategies (duplicate imitation, creative imitation or original innovation) as developing new products may significantly improve its performance in the product market. As a general policy, governments can provide support and encourage firms to actively engage in new product development, which may also contribute to the competitiveness of the country.

When looking into the impact of R&D strategies on firm performance, I find that a higher level of originality in R&D strategy, namely, creative imitation against duplicate imitation, or original innovation against creative imitation, produces more significant and positive effects on firm performance in market share, profitability and total sales. Therefore, a more original innovation strategy is the most effective in improving firm performance. A more duplicate imitation strategy is the least effective in improving firm performance.

It is important to achieve a better understanding of how firms in emerging economies compete with their foreign counterparts (Li and Kozhikode,

2008). By imitating and learning, some indigenous firms in emerging economies have developed from being contract manufacturers or suppliers for foreign partners to being major competitors of their previous foreign partners (Luo et al., 2011). In a rapidly developing economy such as China, which is going through changes in many aspects (Peng et al., 2004), consumers are now facing more varieties of products available in the market, and firms which are unable to offer more creative products are likely to fail (Zhou, 2006).

This study reveals that imitation can take two forms, duplicate and creative, and they affect firm performance in many aspects. All else being equal, a more original innovation strategy is the most effective in improving firm performance, while a more duplicate imitation strategy is the least effective in doing so. An innovation strategy enables firms to lead rather than respond to market demands, and innovators can learn technological advances quickly, which enables them to outperform others even in heavy competition (Kim and Nelson, 2000). The findings confirm that a more original innovation strategy is the best choice for China's indigenous firms.

Moreover, as a creative imitation strategy is the 'bridge' for Chinese firms to transform from imitators to innovators, China's current NIS needs to build networks, enhance property rights protection and offer various information to creative imitators. This is a must-do step for China to become an innovative country.

This study also reveals the positive effects of China's NIS on firm performance. It is not surprising to observe such positive effects because they arise from the tremendous efforts made by China in R&D. China has established various governmental institutions to facilitate R&D (Zhong and Yang, 2007). Now, China is increasing its expenditure on R&D year by year,

aiming to set up NIS that generates more R&D outcomes of higher quality (Boeing, 2010). In the meantime, with such encouraging and constructive NIS, firms engaging in creative imitation over duplicate imitation, or original innovation over creative imitation are likely to be rewarded more in firm performance with support from NIS. This further reveals the advantages of adopting a creative imitation strategy or an original innovation strategy.

The results reveal that NIS improves firm performance in China. As a general policy, first of all, Chinese governments can make efforts to build networks and motivate interactions between the social/economic agents. For firms, actively interacting with other firms, business partners, R&D institutions and universities is a good way of improving firm performance.

In addition, Chinese governments should strengthen the enforcement of laws and regulations and take part in international cooperation on property rights protection (Qiu and Yu, 2010). The protection should be more focused on trademarks and patents because they are economically valuable assets for both foreign and indigenous firms, especially those technology-intensive and internationally-focused firms (Kogan, 2006). For firms, they should acquire training and information regarding how to use the weapon of law to protect their interests and stay close to the patent office in order to detect any possible violations of property rights and protect their own returns in time.

Further, firm performance is promoted by a firm's access to information. This confirms that a firm is embedded in an external environment and, as a result, has the potential to access R&D resources from an external knowledge context. This exposure can influence innovation as North (1993) suggests that "the incomplete information and limited capacity by which to

process information determine the cost of transacting, which underlies the formation of institutions and the cost of transacting rises because information is costly and asymmetrically held by parties to the exchange" (p.2). Government can offer high-quality technological and market information to firms and provide support to help improve firms' ability to manage such information. The technological and market information should be made publicly available and accessible for firms (Middleton, 2005). For firms, working closely with governments, industrial associations and other firms to acquire information on technology development and product market may help them improve market performance.

The results from this study suggest mixed spillovers from FDI on firm performance. FDI positively affects total sales and insignificantly affects market share and profitability.

As observed, the positive changes in R&D strategies help to moderate FDI spillovers. Therefore, firms can upgrade their R&D strategies, transforming from duplicate imitators to creative imitators, and then to original innovators, in order to make good use of FDI spillovers. Governments should allocate resources and support firms in doing so. During this process, the role of a creative imitation strategy should be stressed.

The positive changes in NIS also help to moderate FDI spillovers. As a general policy, governments can build up networks between organizations, facilitate interactions, promote information and knowledge sharing and strengthen property rights protection to help firms make good use of FDI spillovers.

5.7 Conclusion

R&D is important for attaining competitive advantages and improving performance (Kim and Nelson, 2000). There are three different R&D strategies: duplicate imitation, creative imitation and original innovation. The existing research tends to focus mostly on innovation and firm performance, and imitation tends to be treated as a uniform strategy without making a distinction between whether the imitation is duplicate or creative. Moreover, on the one hand, China has established various governmental institutions to facilitate NIS, aiming to set up NIS that generates more R&D outcomes of higher quality than before, and, the other hand, despite the absolute increase in R&D investment, imitations in China are still prevalent. The intellectual property theft and violations have increased rapidly in both volume and range of products affected (Gassmann et al., 2012). This has raised doubts regarding the effectiveness of China's NIS.

Focusing on the Chinese context, this chapter distinguishes between duplicate imitation, creative imitation and original innovation within China's manufacturing context. Four main research objectives are addressed. First of all, it looked at the impact of a firm's being an imitator/innovator or not on its firm performance. It confirms that firms taking an imitation or innovation strategy are more likely to enjoy better firm performance than those doing otherwise. In addition, it investigated the role of R&D strategies (duplicate imitation, creative imitation and original innovation) in affecting firm performance. It reveals that a more original innovation strategy is the most effective in improving firm performance, while, a more duplicate imitation strategy is the least effective in doing so. Further, it investigated the impact of FDI and NIS on firm performance. Mixed spillovers from FDI and positive effects from NIS on firm performance are found. Last, it

investigated the moderating roles of R&D strategies and NIS on FDI spillovers. Positive moderation roles of both R&D strategy and NIS in FDI spillovers are found.

The empirical results have significant implications for firms and governments in China. As a general strategy, a firm can engage in new product development and introduction by using R&D strategies (duplicate imitation, creative imitation or original innovation), as developing new products may significantly improve performance in the product market. As a general policy, governments can provide support and encourage firms to actively engage in new product development, which may also contribute to the competitiveness of the country. More importantly, a more original innovation strategy is the most effective in improving firm performance. A more duplicate imitation strategy is the least effective in improving firm performance. The positive changes in R&D strategies can also help to moderate FDI spillovers. It is worth mentioning that since a creative imitation strategy is the 'bridge' for Chinese firms to transform from imitators to innovators, China's current NIS needs to build networks, enhance property rights protection and offer various information to creative imitators. This is a must-do step for China to become an innovative country.

NIS improves firm performance in China. As a general policy, first of all, Chinese governments can make efforts to build networks and motivate interactions between the social/economic agents. For firms, actively interacting with other firms, business partners, R&D institutions and universities is a good way of improving firm performance. In addition, Chinese governments should strengthen the enforcement of laws and regulations and take part in international cooperation on property rights protection (Qiu and Yu, 2010). Firms should acquire training and information regarding how to use the weapon of law to protect their

interests and stay close to the patent office in order to detect any possible violations of property rights and protect their own returns. Further, firm performance is promoted by a firm's access to information. Government can offer high-quality technological and market information to firms and provide support and help improve firms' ability to manage such information. The technological and market information should be made publicly available and accessible for firms (Middleton, 2005). For firms, working closely with governments, industrial associations and other firms to acquire information on technology development and the product market may help them improve market performance. The positive changes in NIS also help to moderate FDI spillovers.

Chapter 6: Conclusion

6.1 Introduction

This chapter summarizes the major research findings and research contributions, states the managerial and policy implications, acknowledges the research limitations and makes recommendations for future research. Below, section 6.2 presents the major research findings of the thesis. Section 6.3 summarizes the research contributions. Section 6.4 proposes implications for corporate managers and policy makers. Section 6.5 states the research limitations and also make recommendations for possible future studies.

6.2 Summary of Major Research Findings

By employing an institution-based view, chapter 3 investigates the role of formal institutions and FDI in the innovation of China's manufacturing firms, and the role of formal institutions in FDI spillover effects. These relationships are empirically tested by using the *World Bank Enterprise Survey 2003 (WBES2003)*. By employing a range of measurements representing different aspects of innovation, the following findings are obtained: 1) FDI generates negative spillover effects on patents; 2) formal institutions as reflected by property rights protection, government assistance and R&D services positively affect new product sales, patents and new product and new process innovation; 3) formal institutions positively moderate the negative FDI innovation effects.

In addition, in contrast to the firm-perceived formal institutions, chapter 4 looks at the role of formal institutions at regional level. It examines the role

of regional formal institutions and FDI in the innovation of China's manufacturing firms, and in regional innovation in China, by using the *World Bank Enterprise Survey 2012 (WBES2012)* for firm-level innovation data, the *China Statistical Yearbook* for regional innovation data and the *NERI Index of Marketization of China* for regional institution data. Compared with chapter 3, chapter 4 reports the following findings: 1) FDI generates no spillover effects on Chinese firms' innovation (the patent data has been removed from *WBES2012*) and no spillover effects on the regional innovation; 2) regional formal institutions as reflected by government support, financial institutions, educational institutions and taxation institutions promote new product sales, new product and new process innovation and the application of new process innovation in the production of Chinese firms, while the study fails to discover such an impact from legal institutions; 3) regional formal institutions promote regional innovation through positively affecting the total amount of new product sales and the total number of patents granted. Also, the study finds that regional formal institutions promote all three types of patent granted in a region: invention, utility model and external design.

Further, in contrast to looking at the formal institutions, chapter 5 looks at the role of firm-perceived national innovation system (NIS) and a firm's R&D strategy. It investigates the role of NIS, R&D strategy and FDI in the performance of China's manufacturing firms, and also examines the role of R&D strategy and NIS in FDI spillover effects, by using the *World Bank Enterprise Survey 2003 (WBES2003)*. The findings suggest that 1) firms taking an imitation or original innovation strategy are more likely to enjoy better firm performance than those doing otherwise; moreover, firm performance is positively linked to the level of originality in a firm's R&D strategy, with a more original innovation strategy being the most effective in improving performance, while a more duplicate imitation strategy is the

least effective; 2) NIS as reflected by networking, property rights protection and access to information promotes firm performance in market share, profitability and total sales; 3) FDI generates positive spillover effects on total sales; 4) FDI spillover effects are positively moderated by a firm's R&D strategy and NIS.

The findings can be generalized to emerging countries because many of them are eager to attract FDI, build up formal institutions and innovation systems, aiming to enhance their technological and R&D capabilities and innovation performance. Also, the findings can be generalized to East Asian countries because they share many commonalities in institutional framework and buildings and they pursue the similar R&D trajectory to catch up.

6.3 Research Contributions

The role of formal institutions, R&D strategy and NIS in innovation and performance and in FDI spillover effects have been largely neglected in the existing literature. This thesis promotes the research agenda of international business through investigating several main determinants of innovation and performance. After reviewing the existing literature and conducting empirical analysis, this thesis makes a number of contributions as follows.

Following the institution-based view, formal institutions should be put in the forefront rather than treated as "background" when investigating innovation (Lu et al., 2008). The institution-based view has been largely neglected when studying the innovation of firms, especially when we put in the research context in China where there is strong institutional impact on firms (Dunning and Lundan, 2008). This thesis fills the research gap and enriches

the institution-based view through examining the role of formal institutions in innovation of Chinese manufacturing firms. It explores three aspects of formal institutions, namely, government assistance, property rights protection and R&D services. The empirical findings suggest that formal institutions positively affect the innovation of Chinese manufacturing firms.

In addition, different regions tend to have different regional formal institutions (Asheim et al., 2011), and this is especially true for a country like China with more than 30 provinces. Existing studies on formal institutions tend to focus on the national institutions (Edquist, 2006; Lu et al., 2008), neglecting the diversities across regions within a single country. Moreover, as the engine of economic development, the determinants of innovation still require further exploration. However, the role of regional institutions in innovation is under explored (Liu et al., 2014). In order to address the research gap and enrich the literature about regional institutions, among the first attempts, this thesis examines five main aspects of regional formal institutions in China, including government support, legal institutions, financial institutions, educational institutions and taxation institutions. It investigates their role in the innovation of Chinese manufacturing firms, and in the regional innovation of China. The empirical results suggest that regional formal institutions promote the innovation of Chinese manufacturing firms, except for the legal institutions. In addition, regional formal institutions promote regional innovation.

Further, R&D is important for attaining competitive advantages and improving performance (Kim and Nelson, 2000). There are three different R&D strategies: duplicate imitation, creative imitation and original innovation. The existing research tends to focus mostly on innovation and firm performance, and imitation tends to be treated as a uniform strategy without making a distinction between whether the imitation is duplicate or

creative. Among the first attempts, the thesis enriches the literature on R&D strategy and addresses the research gap through assessing the role of R&D strategy in the performance of Chinese manufacturing firms. The empirical findings suggest that firms taking an imitation or original innovation strategy are more likely to enjoy better firm performance than those doing otherwise. Moreover, firm performance is positively linked to the level of originality in a firm's R&D strategy, with a more original innovation strategy being the most effective in improving performance, while a more duplicate imitation strategy is the least effective.

Moreover, China has established various governmental institutions to facilitate NIS and enhance the performance of Chinese firms. China has also implemented the STDP 2006-2020, aiming to transform China into an innovative country by 2020, and a leader in innovation by 2050 (Boeing, 2010). Such efforts have borne fruit as the performance of many Chinese manufacturing firms is improving. Extending the literature of NIS, the thesis looks into the impact of NIS on the performance of Chinese manufacturing firms. NIS as reflected by networking, property rights protection and access to information promotes the performance of Chinese manufacturing firms in market share, profitability and total sales. While, the role of access to information in firm performance still needs to be enhanced.

Last, this thesis is one of the first attempts to extend the literature of FDI spillover effects through investigating the role of formal institutions in FDI spillovers. The empirical findings suggest that formal institutions positively moderate the negative FDI innovation effects on Chinese manufacturing firms. Also, extending the FDI spillover literature, among the first attempts, the role of R&D strategy and NIS in FDI spillover effects is investigated and the empirical findings indicate that FDI spillover effects are positively moderated by a both firm's R&D strategy and NIS.

6.4 Research Implications

The thesis has indicated important managerial and policy implications for corporate managers and governments. Findings from the first research question (chapter 3) imply that acquiring government assistance, using law to protect their interests and access to high-quality R&D services are important for firms' innovation. Governments and economic agents have information, connections and networks which can help firms accelerate their innovation process and make profits on their investments. Also, there are still a large number of illegal imitations and violations of property rights in China (Gassmann et al., 2012), so firms need to strengthen their awareness of law and use the 'weapon' of law to protect their returns from R&D. Firms should also develop their own technological capabilities (invest into R&D and recruit/train technological personnel) to compete with foreign firms in patenting and in overcoming 'crowding-out' effects associated with FDI. For governments, enhancing property rights protection, offering assistance of high quality to firms and making high quality R&D services available and affordable are important as these can help firms improve innovation capability. FDI clearly has a negative effect on the patents of indigenous manufacturing firms. This in a way demonstrates that competition between MNEs and indigenous Chinese firms is fierce, which negatively affects the latter's innovative efforts and they may be forced to concentrate more on production rather than original research. Because of the focus on the integration between adaptive innovation and production, the positive and negative FDI spillover effects balance each other out, therefore the impact appears to be statistically insignificant on other aspects of innovation as well. Meanwhile, the positive changes in China's formal institutions help to mitigate the negative innovation effects from FDI. As a general policy,

governments can encourage indigenous innovation by building a more formal innovation-supporting institutional framework, and offering strong incentives for local firms to carry on creative innovation, apply patents and integrate product and process innovation with business activities.

In addition, findings from the second research question (chapter 4) imply that access to finance in a region is important for the innovation of firms in that region as this reduces the costs of innovation and gives firms incentives to innovate. Also, building links with regional R&D and educational institutions and training bodies is important because it increases the opportunities and enhances capability in firms' innovation. In the meantime, firms should build close contacts with regional governments and gain government support in R&D. For governments, reducing the tax burden upon firms is important because this reduces firms' costs and increases their incentives for innovation. Moreover, developing educational institutions and the financial market and providing firms with R&D support are shown to be effective ways of improving firms' performance in innovation. Also, improving efficiency of law enforcement is necessary as it can protect the returns from firms' R&D and give them incentives to innovate. All of the above efforts made in improving regional institutions can also help to enhance regional innovation.

Further, the findings from the third research question (chapter 5) imply that firms that take a more original innovation strategy are likely to have the best firm performance, while firms that take a more duplicate imitation strategy are likely to have the worst firm performance. Therefore, firms should transform themselves from duplicate imitators to creative imitators and then to original innovators in order to achieve better performance. For governments, helping firms with their upgrade in R&D strategies is important. This is also a must-do step for China to achieve its objectives set

in its STDP and become an innovative country. NIS on the whole produces a significant and positive effect on firm performance. Therefore, for firms, acquiring support and resources from NIS such as protection on property rights and access to various information is important. Also, networking and interacting with other organizations is an effective way for firms to improve performance. For governments, building networks between various social agents is crucial. Also, governments should strengthen property rights protection and offer high-quality technological and market information to firms in order to help them build up capabilities in R&D and the marketplace. As observed, the positive changes in R&D strategies help to moderate FDI spillovers. Therefore, firms can upgrade their R&D strategies, transforming from duplicate imitators to creative imitators, and then to original innovators in order to make good use of FDI spillovers. Governments should allocate resources and support firms in doing so. During this process, the role of a creative imitation strategy should be stressed. The positive changes in NIS also help to moderate FDI spillovers. As a general policy, governments can build up networks between organizations, facilitate interactions, promote information and knowledge sharing and strengthen property rights protection to help firms make good use of FDI spillovers.

6.5 Research Delimitations and Future Research Recommendations

It is important to bear in mind the caveats when interpreting the findings from this thesis. First of all, one limitation is associated with the measurement of formal institutions and regional formal institutions when I investigate the first research question (chapter 3 and 4). There are many aspects of formal institutions that may influence innovation, ranging from

initiatives to increase the capacity of researchers and financial incentives that attract high value added innovation FDI to educational institutions. Some policy initiatives may conflict with one another. Policy initiatives and tax incentives may vary by region. Educational institutions contribute to the development of innovation infrastructure as well as indirectly affecting firms' capacity to make use of FDI spillovers. Formal institutions may also vary over time. Unfortunately, such data is unavailable in terms of firm-perceived formal institutions, which will inevitably hinder the production of a more complicated analysis. Moreover, the measurements of regional formal institutions are restricted to those five aspects, and other areas of regional formal institutions cannot be investigated. Future research can have a more comprehensive measurement of formal institutions if the data on other aspects of firm-perceived formal institutions is available, which can help to reflect a more complete picture of the business environment and assist the analysis of association between institutional environment and innovation performance of firms.

In addition, another limitation is associated with measurement of firm-perceived NIS when I investigate the third research question (chapter 5). Several elements can be identified from the definition of NIS by Lundvall (2007), namely, networking (interactions), financial markets, education systems, welfare regimes, intellectual property rights and access to information. However, the dataset *(WBES 2003)* does not allow me to investigate education systems, financial markets and welfare regimes from the firm perspective, which will inevitably hinder the production of a more complicated analysis. Future research can have a more comprehensive measurement of NIS if the data on other aspects of firm-perceived NIS is available, which can facilitate the study of the impact of NIS on firm performance.

Further, the classification of firms that use different R&D strategies (chapter 5) can only capture the likelihood of a firm being a duplicate imitator, a creative imitator or an original innovator. It cannot capture what type of R&D strategy a firm exactly adopts in practice, which restricts me from doing a more comprehensive analysis. The identification of what R&D strategy a firm actually adopts is important because it can assist the analysis of the specific impact of the R&D strategy and indicate direct managerial and policy implications. Future research should consider more comprehensive components and design a better method of classifying firms according to their R&D strategies.

Moreover, one of the main datasets that I used to investigate the first and third research questions (chapters 3 and 5) is the *WBES 2003*, covering the period from 2000 to 2002. This dataset is old, so it may not fully reflect the situation of China and Chinese firms today. Nonetheless, there are also *2002 and 2005 WBESs* on Chinese enterprises. However, different questionnaires were used in those surveys which do not contain many of the variables under investigation, e.g. property rights protection, access to information and profitability, and therefore they are not used. Unfortunately, the new *2012 WBES* also does not contain many of the variables under investigation, including market share, profitability, R&D strategy (no patents), access to information, property rights protection and number of competitors; therefore it is not used either. Future research may use a new and more complete dataset on China's investment climate and business environment to investigate the institutional development and impact on Chinese firms if the data is available. Using a new and more complete dataset may help to reflect a more recent picture of China's institutional development and impact and improve the credibility and robustness of the findings.

Additionally, the institutional variables in chapter 3 and NIS variables in chapter 5 are based on managers' perceptions collected by *WBES 2003*.

These institutional variables are associated with managers' perceptions of property rights protection, government assistance and R&D services in China. The NIS variables are associated with managers' perceptions of networking, property rights protection and access to technological information. Kaplan and Pathania (2010) suggest that firms' perceptions have limitations as the changes in firms' perceptions may not appropriately reflect the changes in investment climate and business environment. Therefore, we should use caution when interpreting the indicators based on firms' perceptions. Future research should bear in mind the caveats of using perception-based measures and interpret the findings with care for the scope of their implications.

Also, due to the unavailability of data, certain potential endogeneity problems cannot be tested such as the possible endogeneity between profitability of firms and their probability of developing new products.

Meanwhile, this thesis cannot investigate the role of informal institutions in innovation because the data is not available and it is hard to measure informal institutions, also because of the failure of this thesis to disentangle the effect of informal institutions from that of formal institutions. Future research can investigate the impact of both formal and informal dimensions of institutions on the innovation of Chinese firms if data of reflecting informal institutions in China is available.

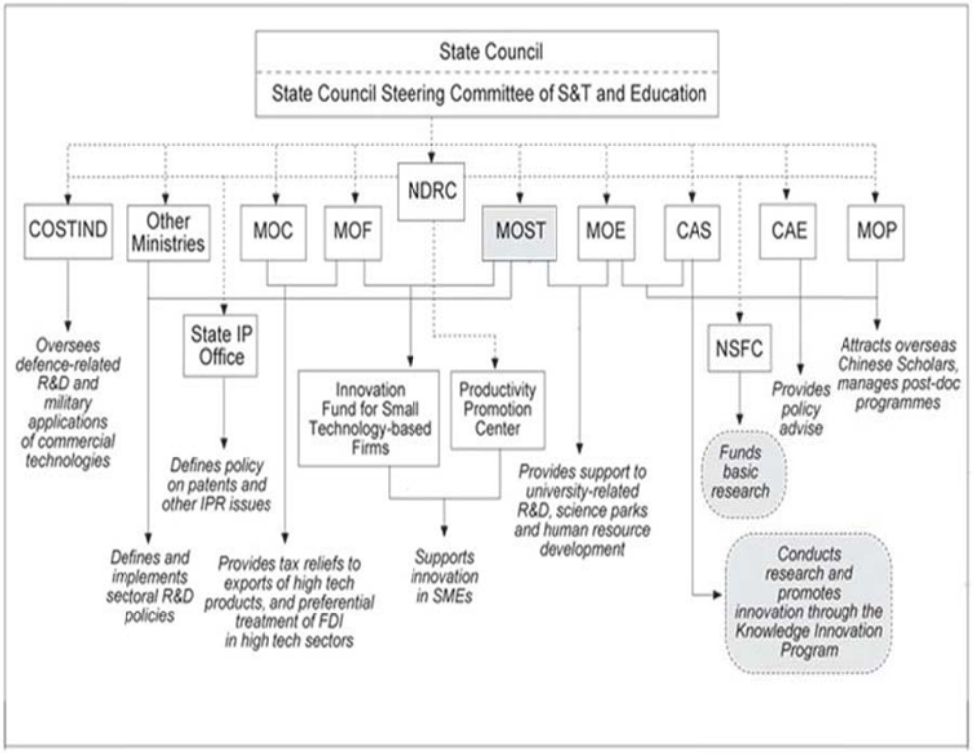
What is more, this thesis uses secondary data to do an econometric analysis in order to investigate the three research questions. It does not use other methods of research such as interviews and case studies. Hurmerinta-Peltomäki and Nummela (2006) assert that international business is associated with multiple areas of studies which are cross-national, cross-cultural, cross-organizational and cross-personal, and

inspire complex research questions. Therefore, a single and narrow method of research may be inadequate to reflect the facts and capture the complicated context. Future research can try to use both quantitative techniques and qualitative methods such as interviews and case studies, using both secondary and primary sources of data to generate more robust and convincing findings and reflect more aspects of the facts.

Last, in chapter 3, both Spearman test and VIF test suggest the high correlations between three institution variables and their interaction terms with FDI which cause multicolinerity problem, however, I could not find an effective method to deal with it despite I have tried the 'mean-centred' method. I therefore dropped formal institutions variables when interaction variables between formal institutions and FDI are used. However, I realize that the findings from the moderation effects are restricted when I drop the original institutional variables because the indirect effects of formal institutions on innovation of firms through FDI cannot be well tested, which is a limitation of this thesis.

Appendices

Appendix 1 Government Institutions in China's NIS



Source: Zhong and Yang (2007)

List of abbreviations:

CAE: Chinese Academy of Engineering
CAS: Chinese Academy of Sciences
COSTIND: Commission of Science, Technology and Industry for National Defense
MOC: Ministry of Commerce
MOE: Ministry of Education
MOF: Ministry of Finance
MOP: Ministry of Personnel
MOST: Ministry of Science and Technology
NDRC: National Development and Reform Commission
NSFC: National Natural Science Foundation of China
R&D: Research and Development
SME: Small and Medium-sized enterprise
S&T: Science and Technology

Appendix 2 Results of Factor Analysis of NIS

Factor analysis/correlation Number of obs = 1555
Method: principal-component factors Retained factors = 1
Rotation: (unrotated) Number of params = 3

Factor	Eigenvalue	Difference	Proportion	Cumulative
Factor1	1.06459	0.08354	0.3549	0.3549
Factor2	0.98105	0.02669	0.3270	0.6819
Factor3	0.95436		0.3181	1.0000

LR test: independent vs. saturated: chi2(3) = 5.06 Prob>chi2 = 0.1676

Factor loadings (pattern matrix) and unique variances

Variable	Factor1	Uniqueness
NET	0.6316	0.6011
PRP	0.6494	0.5783
ATI	0.4940	0.7559

Scoring coefficients (method = regression; based on varimax rotated factors)

Variable	Factor1
NET	0.59323
PRP	0.60996
ATI	0.46406

Appendix 3 Original Questions used in WBES 2003

Questions for innovation of firms:

1.new products: 1=yes 2= no

2.Sale of new products as % of total sale

3.Patents: 1=yes 2= no

4.Number of patents granted in China

5.What types of innovation have you introduced in your plant since the beginning of 1999?

(1)Introduced new products (or services) in existing business
(2)Entered new business line
(3)New process improvements
(4)New management techniques
(5)New quality controls in production

Questions for firm performance:

1.In 2002 What is the percentage of the total sales in your major market supplied by your firm?

2.Total profits

3.Value of total sales (products and services, including exports)

Questions for formal institutions:

1.In 2002 did any government agency or official assist you in …

(1) Identifying foreign investors
(2) Locating foreign technology to license
(3) Identifying potential foreign clients
(4) Identifying potential foreign suppliers
(5) Obtaining bank financing
(6) Identifying potential domestic clients

2. What's the likelihood that the legal system will uphold my contract and property rights in business disputes?

3. R&D services: Available? (1=Yes 2=No) Affordable? (1=Yes 2=No) Quality ? (1 2 3 4)

Questions for NIS:

1.Did you have a contractual or long-standing relationship with any of the following in the following year?

(1) Local university
(2) Research institution
(3) Firms

2. In a scale of 1 to 5, state whether you're satisfied with the availability/accessibility of information on the following aspects

(1).supply of input/services
(2).demand for your product
(3).export market and import sources
(4).Technical standards
(5).product/technology development
(6).Laws and regulations

Questions for control variables:

1. In 2002 how many competitors do you have within your main business line in domestic market?

(1) 1-3, (2) 4-6, (3) 7-15, (4)16-100, (5) more than 100.

2. Total R&D expenditure

3. Total R&D personnel

4. Value of total exports (products and services)

Abbreviations

APPI	Application of Process Innovation in Production
ATI	Access to Information
COM	Competition
EDU	Regional educational Institutions
EXD	Regional External Design
EXP	Exports
FMR	Regional financial Institutions
FDI	Foreign Direct Investment
GOA	Government Assistance or Regional Government Assistance
INV	Regional Invention
IPR	Intellectual Property Rights
LAW	Legal Institutions or Regional Legal Institutions
MAR	Market Share
MNE	Multinational Enterprise
MOST	Ministry of Science and Technology
NERI	National Economic Research Institute of China
NET	Networking
NIS	National Innovation System
NPcI	New Process Innovation
NPdI	New Product Innovation
NPS	New Product Sales
OECD	Organization for Economic Co-operation and Development
PFT	Profitability
PG	Patent Granted
PNP	probability of developing new products
PP	probability of patenting
PPI	Producer Price Index
R&D	Research and Development
RDE	R&D Expenditure
RDP	R&D Personnel
RDS	R&D Services
RDSG	R&D Strategy
RENPS	Regional New Product Sales
REPG	Regional Patents Granted
RI	Regional Institutions
SAL	Total Sales
SMEs	Small- and Medium-sized Enterprises

S&T	Science and Technology
STDP	Science and Technology Development Plan
TAX	Regional taxation Institutions
TITM	Transactions in Technology Market
TRIPS	Agreement on Trade-Related Aspects of Intellectual Property Rights
UTM	Regional Utility Model
VIF	Variance Inflation Factors
WBES	World Bank Enterprise Survey
WNP	Whether to Engage in New Product Development
WTO	World Trade Organization

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